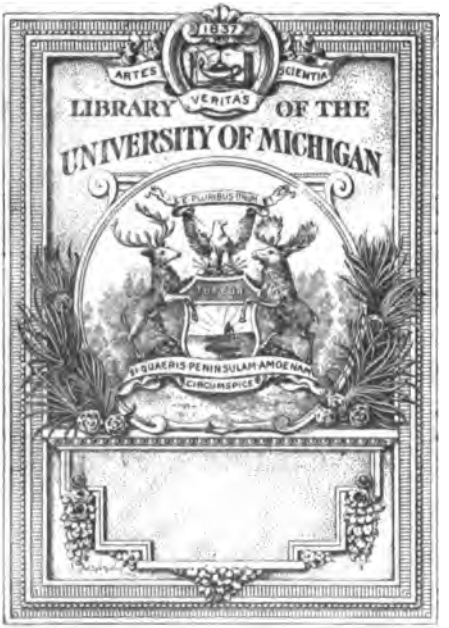

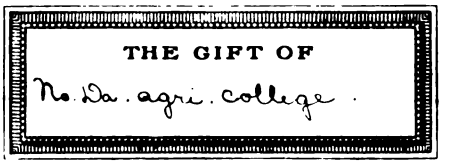

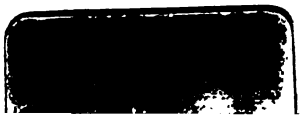

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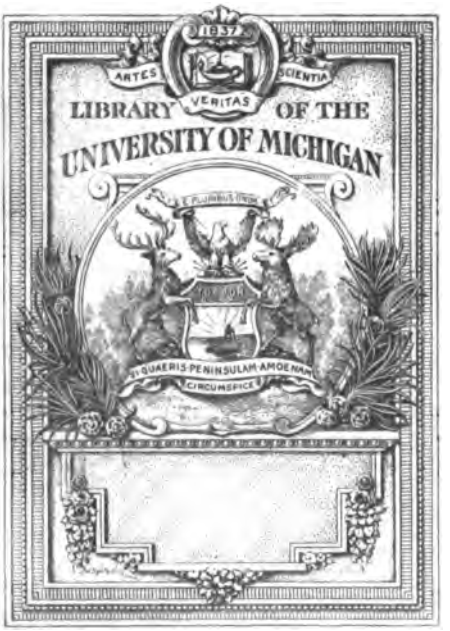
Agricultural College Geological Survey
of North Dakota.



Compliments of
HERBERT A. HARD,
Director,
Agricultural College Geological Survey
of North Dakota.

THE FIFTH BIENNIAL REPORT

OF THE DIRECTOR

OF THE

Agricultural College Survey of North Dakota

TO THE

Governor of North Dakota

Administrative Report and Accompanying Papers
For the Years 1909-1910

HERBERT A. HARD
Director

BISMARCK:
TRIBUNE, STATE PRINTERS AND BINDERS
1910.

THE SURVEY STAFF.

Herbert A. Hard, B. S., Geologist, Chemist, Director of Survey.
Daniel E. Willard, M. A., Director of Survey in 1909.
William B. Bell, Ph. D., Biologist.
E. F. Ladd, B. S., Chemist.
H. F. Bergman, B. S. Biologist.
Harold McKinstry, B. S., First Assistant in Soil Survey.
Edward Clark, Assistant in Soil Survey.

U. S. SOIL BUREAU MEMBERS.

Frank Bennett, Assistant in Soil Survey.
E. L. Worthen, Assistant in Soil Survey.
Rex E. Willard, Assistant in Soil Survey.
E. B. Watson, Assistant in Soil Survey.

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Frank Sanford — Arja Bowen

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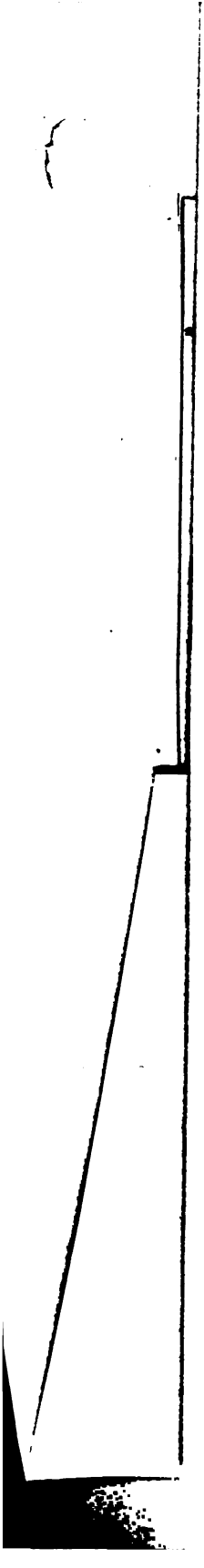


LETTER OF TRANSMITTAL.

Hon. John Burke, Governor of North Dakota:

SIR:—I have the honor to present to you the Fifth Biennial Report of the Agricultural College Soil and Economic Survey of North Dakota for the years 1909 and 1910.

In my administrative report, you will find the history of the survey briefly outlined; the different lines of investigation and research pursued and recommendations for the needs of the future work set forth.

The accompanying papers will clearly indicate the various lines of work undertaken.

A fair idea of the importance of the survey is made plain from the requests sent in asking that the work be extended, and from the accord with which it is received by farmers and business men in localities which have been investigated. It is therefore recommended that this report be published and distributed to all who desire the same.

Very respectfully,

HERBERT A. HARD,
Director.

Agricultural College, North Dakota, November, 1910.

THE FIFTH ANNUAL REPORT.

OF THE

AGRICULTURAL COLLEGE SURVEY

OF NORTH DAKOTA.

By Herbert A. Hard, Director.

History and Purposes.—The Agricultural College Survey was organized by act of the legislative assembly of 1901. This instrument calls for a topographic, agricultural and economic survey of the state. It is required that data concerning climatic conditions be recorded for various parts of the state; that the various soil types be analyzed, the qualities and value determined, and a map made of the same; that the surface and artesian water supplies be investigated; and that the existing agricultural conditions and methods of farming be studied with the idea of their betterment. This information, accurately obtained, should be of great value in developing the resources of a state essentially agricultural.

It is a fact of nation wide importance that the broad area of a great state, larger in size than that of all New England, and but recently classified as arid desert, should have in it the capacity for so rich habitation of man. The development of the agricultural resources of North Dakota within the last decade has been little less than marvelous. The coal and clays are also revealing a great mineral wealth.

Soil may be defined as a geological specimen, the complexity of which is very great, and of such nature that it may only be interpreted in the light of a thorough understanding of the geology of the region in which found. The direction of this survey was placed under the control of the head of the Department of Geology.

Soil is the residue of rocky decay and as such must partake in some measure of the composition and character of the parent rock modified by the particular character and time relation of the weathering process. Dynamite forces may sort the disintegrated mass, depositing unproductive materials in one area and to a certain extent con-

centrating richer crop-producing ingredients in another. The supply of ground water for the growing plant is intimately dependent upon the geological structure of the rock beneath. From these facts it is quite apparent that the biological, chemical, agricultural and soil departments of the experiment station should closely cooperate.

Organization.—The soil survey was established by the state with the understanding that the federal government would cooperate in the work, bearing equal expense. This and more it has done during the greater part of the ten years of active field operations, contributing three or four dollars to every one from the state. While the College Survey is cooperative with the Federal Survey, it expends the state appropriations independently. For all expenditures, for subsistence in the field, salaries for services, for the purchase of materials, sub-vouchers are taken, after the manner of the efficient system practiced by the federal government. Itemized statement of all expenditures is made to the secretary of the College.

The first biennial period of the survey was under the management of the late Prof. C. M. Hall. A detailed soil and hydrographic examination was made of about twelve townships in Grand Forks County. Mr. C. A. Jensen, of the U. S. Department of Agriculture, had charge of the field work. Federal funds alone effected the preparation of the Wahpeton topographic sheet in 1902. A preliminary geologic and economic map was prepared.

Upon the death of Prof. Hall the direction of the survey was assumed in 1903 by Prof. D. E. Willard and continued by him until early in 1910, when he was made Development Agent for the Northern Pacific Railroad with headquarters in St. Paul, a position for which his past wide experience in kindred lines admirably qualfy him.

Second Biennial Period.—In the second biennial period, 1903-4, about 1,260 square miles of soil were surveyed, consisting of eleven townships or 406 square miles in Cass County, known as the Fargo area; 496 square miles or fourteen townships in Stutsman and Barnes Counties known as the Jamestown area; two townships in Ward County known as the Minot area; about 288 square miles or eight townships in Towner County known as the Cando area. Large advancement was made in the investigation of the water supply of the state. Topographic work by federal government gave the

Wyndmere sheet. Nine topographic maps had previously been made, consisting of Fargo, Cassleton, Tower, Eckelson, Jamestown, Pingree, Wahpeton, La Moure, Edgely. Since then but one sheet, the Bismarck, has been completed.

Third Biennial Period.—During the third biennial period, 1905-6, some 2,200 square miles of soil were surveyed, the federal government and private citizens aiding largely. Of this 460,800 acres or twenty townships in southern Griggs and Foster counties are known as the Carrington area. The Williston area in Williams county includes 585 square miles, sixteen and one-half townships.

Through the aid of the Agricultural College a Biological Survey was instituted and considerable progress made under the direction of Dr. W. B. Bell. Native plants adaptable to the soil and climatic conditions of the area are studied in order to determine which ones are worthy of cultivation. This will naturally indicate what foreign plants may be introduced.

Fourth Biennial Period.—In the fourth biennial period, 1905-6, about 2,300 square miles of soil were surveyed, consisting of ten townships or 348 square miles in McKenzie County, sixteen townships or 544 square miles in Morton County; Richland County entire or about 1,450 square miles.

This latter large work was made possible through the progressive spirit of the inhabitants of the county, who contributed $1,000 to aid in the survey.

Fifth Biennial Period.—During the summer of 1909 a detailed field study was made of the flora of the sandy soils in the vicinity of McLeod, Ransom County. Collections of plants were made illustrating the plant relationship to the somewhat peculiar topographic and soil conditions of this region. A brief report giving certain recommendations regarding the crops suitable for this regon, as indicated by the study of the native plants, was published in the previous (1907-8) report.

In addition to the detailed work in this locality, collections of plants were made from the typical soil areas found in the entire county of Ransom, thus giving an abundance of material for a study of the variations in plant life due to the varied soil conditions, and showing the characteristic flora of these soil types. In the Biological Department the summer of 1910 was devoted to preparation of reports on previous field work.

As a summary of all his previous work in the state Professor Willard prepared an elaborate soil map in colors of the entire state. The map is 18x30 inches and is therefore somewhat general. Detail maps as far as possible were used and other areas interpolated and correlated as closely as possible, giving what purports to be a general classification of the soils of the state, an admirable work of its kind. This is just such preliminary map as the federal government has made in the states west of the 100th meridian, before starting the detailed survey.

The continued cooperation of the federal government was made possible through the liberality of the Northern Pacific Railroad, of private citizens in Lisbon and Williston, and of Richland county as above noted.

In the field season of 1909 three townships in Billings County, comprising the Beach area, were completed, likewise four townships, the Page area, in Cass County. A very detailed survey was made of sixteen sections of the drifting sand dunes of eastern Ransom County and of 708 acres, the Rourke farm, in southern Cass.

The present director assumed his duties in the summer of 1910. The Survey funds had not been sufficiently large to warrant federal cooperation being arranged for the winter previous. Hence what work has been done was under the direction of the state alone. The yearly appropriation of $1,000 has been made to cover as ample survey as possible.

Mr. Harold McKinstry, competent assistant of previous seasons, and the writer, have surveyed the Dawson and New Salem soil areas, detailed accounts of which appear in this volume. Mr. McKinstry, as first assistant, had charge of the soil sampling and to him credit is due for completing the tedious but painstaking work of mechanical analysis of soil types.

Data on underground and surface water supply was collected in Kidder, Burleigh and Morton counties. The height of water table was studied with reference to its availability for use in wells, and this, with small surface streams, for irrigation of certain limited areas.

Outlook for Sixth Biennial Period.—In the ten years existence of the Survey about 6,750 square miles of the state, a little less than one-tenth of its area, have been covered by a systematic quarter-section canvass of soil types and economic conditions. Plainly this work should be done at a more rapid rate.

In every area in which survey has been made great interest has been taken by a large number of wideawake farmers, dairymen, real estate men, county officials and others, who forcibly express themselves as appreciating the fact that the survey will greatly aid in directing desirable settlers towards the area and assist in its development. In fact, surveys are asked for certain areas by the people themselves, or by their officials—as in the case of Richland, Williams and other counties—even before sufficient appropriation has been made by the state to prosecute such work. So carefully is the value of lands determined that the commissioners of Richland expressed themselves as requiring the survey as means of getting at valuation for assessment. Frequent inquiries from prospective farmers and from real estate men are received at the office of the director for information, such as the survey secures, as to the value of lands in all sections of the state.

The state has a large variety of soils. The purpose of the survey is to determine just what and how extensive all of these types are, and to find their crop adaptability. The experiment stations and demonstration farms of the Agricultural College are placed on as many of these different soil types, with as many different conditions of climate, etc., as possible. The general soil type having been selected, and the experiment farm established, the survey then follows with its detailed quarter-section canvass of soils in all adjacent areas. The field party aims to classify and map all types of soil comprising an area of ten acres or more. Thus all farmers in that locality may have access to the information, scientifically obtained, as to crop requirements on soils identical with or similar to their own. From each station there should radiate a field of influence making for improved methods of soil and crop management. The average settler has not the time or money, even if he has the information required to experiment with a new and untried soil. The survey and experiment farm can supply this need.

As stated before the field work of the survey should progress more rapidly. At the present time cooperation with Washington has been suspended owing to the meager investment of the state in the work and, unless this is renewed, progress will be less in future than in past. Chief Whitney of the Bureau of Soils, has assured the director that aid will be given by the federal government to exceed any reasonably large appropriation made at the coming session of the state legislature to carry on soil or topographic survey. He has

asked the writer to select a county in eastern North Dakota for a detailed survey in the summer of 1911. This opportunity to secure the application of federal moneys to the needs of North Dakota must not be ignored.

In addition to sustaining the federal surveyors in the field, it is the custom of the government to pay all livery bills of the state party as well, one of the largest expense items incurred.

At this point a strong plea should be made in behalf of the needs of the topographic survey and for means of preservation of the valuable soil, mineral and other specimens collected by each field party.

It is the purpose of the United States Geological Survey to cooperate with all states in the preparation of their topographic maps, so that ultimately a topographic map of the whole country may be completed. When it is noted that the topographic map is the basis of all soil, water supply and other geologic surveys and mapping, the extreme importance of this phase of the work is apparent. While it was originally intended that the state survey should include topographic mapping, no appropriation has as yet been provided for it; and the eight sheets now complete were made at federal expense.

Each field party returns from its labors with a large collection of choice specimens of minerals and soils or plants and animals. These accumulate in basement or attic and often rapidly deteriorate for want of preparation, mounting and suitable museum space for display, or as often, the specimens are acquired by the assistants, since there is no provision for their preservation. The writer knows at the present time of individual specimens and small collections of North Dakota minerals and rare prehistoric relics which can be obtained for a nominal sum or at no cost at all to the state. These collections are invaluable and I respectfully urge that in accordance with the sentiment of the provision in Sec. 4, Chap. 8, Session Laws 1901, the appropriation of money be made sufficient to equip a room in Science Hall for use as a museum.

Much work along the line of chemical investigation and analysis is imperative, but no plea is made for this at present, as it is felt that means for soil and topographic surveys and for preservation of materials are more crying needs.

Summarizing the above, I respectfully urge the appropriation of $2,500 annually to be applied at the discretion of President Worst and the director upon the various needs of the Soil and Economic Survey of the Geological Department of the Agricultural College.

NOTES ON THE WATER SUPPLY OF MORTON, BURLEIGH AND KIDDER COUNTIES, N. D.

By Herbert A. Hard.

Description of Area.—The counties studied lie in the south central part of the state and the areas more carefully observed were northern Morton, southern Burleigh and central Kidder, for about two hundred miles along the line of the N. P. R. R. The tract for the most part lies in the glaciated area, but Morton County marks what was the limit of the southwestern extension of the active glacier. Hence the surface formations and topography vary from those of the typical glaciated area on the east side to those of natural weathered outcrop on the extreme west. Transported soils are found in the east and those which are, in part at least, residual in the west. A soil survey of an area of each type at each end was made the past summer. In the east the morainic topography varies from gently undulating to rough; while in the west native rock, more or less completely decayed, varies in contour from gently undulating to the rough broken lines of bad land buttes.

Altitude.—A good idea of the general altitude of the three counties is obtained by consulting the levels of the N. P. right of way, the highest point in Kidder county being 1,870 feet and the lowest point 1,740 feet above sea level. The range in Burleigh is from 1,870 to 1,640 feet and in Morton, which is, roughly, about as wide as both Kidder and Burleigh counties, from 2,210 to 1,630 feet.

Rainfall.—As indicated in other chapters the cimlate is semi-arid, the precipitation being from about fourteen inches per annum in the west to a little over sixteen inches in the east. Thus we see the necessity of a close study of the water resources of this area which is typical of the western two-thirds of the state. Hence the need of water conservation, irrigation, dust mulch, and dry farming tactics. As about two-thirds of the rainfall is in the growing season, this is ample in all but exceptional years to insure fair crops, if only the supply is conserved.

Possibility of Supplementing Precipitation.—The soils of the area show quick response to any local application of moisture in amounts even moderately in excess of the normal rainfall. This is readily shown where snow has drifted or found lodgement in any large amount about obstacles in the fields. This snow, melting there in the spring, wets the area so effectively that the crop makes fine growth, and at harvest, one can see almost to a line where the snow bank stood the previous winter by the rank growth of the grain. Many such spots gave fair crop even in 1910, while a total failure was recorded for the rest of the field. While the water table is too low for easy access to crop roots, it is seen that it is sufficiently high in much of the area as relates to wells, strong supply of water being obtained within a comparatively few feet of the surface. This source, together with the few flowing wells, the rivers and creeks, and the springs such as those feeding the Sweetbriar, would, if properly conserved, suffice to irrigate fairly large gardens or fields. In many wells the water stands high enough to be readily pumped by wind-mills, or, in absence of wind, by engines. With the use of the latter power, irrigation of larger tracts would be possible. In fact we are inclined to think that only those who are too timid deny large possibilities in the line of artificially supplementing the natural precipitation of these counties, as well as that of many other large tracts in the state. To the man of small capital, the considerable expense in establishing such system seems prohibitive. As in the use of fertilizer and in the preparation of a good seed-bed, this large initial outlay finds no sympathy in the users of old-time methods of farming. Those of the old school "have not time" to spend on such improvement.

There are a few flowing wells in the area. A good number of artesian wells are as shallow as twenty feet and very many "surface" wells are but ten feet deep. Many of these are inexhaustible, and supply good water.

Soils.—As observed in another chapter in this report, and in most reports ( ) relating to this region, the soil and subsoil are to a great extent very light and sandy, sand and fine sandy loam predominating. In some areas the subsoil is of very light texture for five or even twenty feet down. Any surface water rapidly percolates, and, not often being renewed, the ground water stands at a low level. However, many areas have heavy soil and subsoil.

a (1) Soil Survey of western N. D. Bur. Soils '08 by Macy H. Lapham.
(2) Soil Survey of Morton area, N. D. Bur. Soils '07 by Thomas D. Rice.
(3) C. T. p. 71.

WELLS.

Burleigh County.—Records of several hundred wells scattered over the area were collected or consulted. These were obtained from the owners or from well makers. Among the latter the author wishes to particularly acknowledge the helpfulness of Mr. Jaskowiak of Bismarck, who allowed him to freely consult his records and journal. A practical well man, Mr. Jaszkowiak also has a general knowledge of geological conditions, which enables him not only to keep good records of the strata through which he bores, but also to understand the general relationship of the water table and its relation to neighboring wells, the water bearing strata, and similar matters. The number of wells he has bored varied from twenty-five in 1898 to 104 in 1908, aggregating 63,933 feet of earth penetrated by 540 wells in eleven years. These and hundreds of other well records taken by well drillers and farmers were put at the disposal of the survey.

In the following tables typical well records were chosen, which show the water rising in the wells to a level comparatively near the surface. True, hundreds of other wells have a deeper level, but on the other hand a very great number could have been given showing quite as good record as those listed. The first table, with records largely from Burleigh County, does not generally show the water, except around McKenzie and Long Lake, rising so near the surface as in other sections.

TABLE I.—WELLS IN BURLEIGH COUNTY.

Owner and Location	Depth of well in ft.	Depth in ft to water
T. Griffin, Bismarck	33	23
T. Griffin, Bismarck	147	75
Wm. McDonald, Bismarck	46	30
City Well, Bismarck	135	25
A. Solberg, Bismarck	120	30
Penitentiary No. 1, Bismarck	115	20
Penitentiary No. 2, Bismarck	115	30
A. D. Welch, Menoken	59	20
A. McDonald, Glencoe	146	30
T. Hamilton, Menoken	150	10
R. Roth, McKenzie	50	25
Mrs. Jessel, McKenzie	80	20
G Kasitzky, Sterling	65	25
G. Johnson, Painted Woods	132	32
No. 1, Britton	300	30
Tp. 140 R. 75, Sec. 27	40	12
Taylor	250	30
Tp. 140, R. 75, Sec. 7	36	12
Tp. 140, R. 75, Sec. 18	40	12
No. 1 Bessoba	50	flows
R. Anderson, Long Lake	120	flows
Tp. 14, R. 75, Sec. 19	36	12

While the wells in Burleigh County generally require a considerable lift, the water is within practicable pumping distance. Further, a large area about McKenzie, and another around Long Lake have the water table at the surface.

The formation in the Missouri Valley at Bismarck for many feet down has been worked over very greatly by water, the washed-in material being composed of gravel, sand, clay and combinations of these in varying proportions and degrees of assortment. The water bearing stratum is usually gravel or quicksand. North and northwest in the lignite bearing region, the water is often struck at the coal. This is also the case at Glen Ullin in western Morton County, where in the entire valley a fine condition of water table, relatively near the surface, is found. The water is soft and clear at twenty-seven feet in all wells observed.

Few very deep wells have been dug. Aside from the 300-foot well at Brittin one was dug at Wilton 415 feet deep. Several two-foot veins of coal were encountered, while at sixty-seven feet an eleven-foot vein was found, which is being worked; 225 feet of compact whitish clay was followed by 100 feet of soft, mushy clay —then blue clay with thin seams of coal. A good flow of water rose high. From the 415-foot level, a diamond drill penetrated to 2,000 feet, finding no more coal and stopping in shale. The following record for William Reuter of a well in Sec. 23, Twp. 148, R. 85, is illustrative, although taken a little north of the area. Data was furnished by Mr. J. K Doran of Bismarck:

FORMATION.

	Feet.
Soil and clay	70
Blue clay	20
Hard sand	4
Blue clay	41
Coal	8
Blue Clay	82
Coal	10
Blue clay	65
Coal	12
Blue clay	88
Coal	18
Blue clay	7

	Feet.
Quicksand	4
Clay	103
Coal	3
Total	535

These may be taken as types of the relatively few deep wells. The water in some wells is hard, in some soft, but usually good.

Some of the clays penetrated are commercially valuable for brick and pottery. The surface deposit at the state penitentiary may be noted as a valuable deposit of very accessible brick clay.

Kidder County.—In Kidder County the water table was found to come nearer the surface as shown by most wells; to afford numerous springs, as at Crystal Springs; flowing wells, as those north of Dawson, south of Steele, etc. In digging these wells, clay was at times encountered all the way down, but more often alternating layers of blue clay, gravel, sand and quicksand.

TABLE II.—WELLS IN KIDDER COUNTY.

Owner and Location	Depth of well in ft.	Depth to water in ft
M. Roberts, Dawson	43	18
I. Smith, Dawson	40	18
R. Funk, Dawson	35	16
R. Anderson, Steele	136	18
I. Loerch, Steele	150	35
R. Raines, Dawson	100	flows
No. 1, Dawson	95	flows
No. 2, Dawson	90	10-15
No. 1, Twp. 140, R. 71, Sec. 20	20	14
No. 2, Twp. 140, R. 71, Sec. 20	25	14
Twp. 140, R. 71, Sec. 14	28	12
Twp. 140, R. 70, Sec. 6	10	2
Twp. 140, R. 71, Sec. 20	40	30
Twp. 140, R. 70, Sec. 18	29	13
Twp. 140, R. 72, Sec. 4	40	16
No. 1, Twp. 140, R. 72, Sec. 6	40	34
No. 2, Twp. 140, R. 72, Sec. 6	18	12
No. 3, Twp. 140, R. 72, Sec. 6	46	11
Twp. 140, R. 70, Sec. 26	30	10
Twp. 139, R. 71, Sec. 24	40	34
Twp. 139, R. 71, Sec. 26	27	16
Twp. 139, R. 70, Sec. 20	12	10
Twp. 139, R. 71, Sec. 34	14	10

Six other wells near Dawson are each twelve feet deep and have an inexhaustible water supply. The records in Table II. are given almost as they were taken, although only those with water at shallow depth are included. These wells, as those in most instances in

the other table, are wells of good strong water supply, the values in column four being practically that of a constant annual water level. Thus in central Kidder County there is a strong water supply very near the surface—near in the sense of a well supply.

Morton County.—A study of wells recorded in Table IV. reveals a water table at nearly as good level as in Kidder County.

TABLE IV.—WELLS IN MORTON COUNTY.

Owner and Location	Depth of well in ft.	Depth to water in ft
Jno. Heid, New Salem	8	*8
H. Kroeger, New Salem	8	*7
Twp. 138, R. 85, Sec. 26	33	8
H. Meier, New Salem	40	30
No. 1, Youngtown	7	*7
No. 2, Youngtown	7	*7
M. Spain, Glen Ullin	30	27
Creamery, Youngtown	7	7

*Strong Source.

These typical shallow wells with strong source of water, and the spring spoken of in the next section show that there is a very accessible supply of water in the county.

A large area in the valley about Glen Ullin has practically the same water level. Thirteen wells examined here were 25 to 35 feet deep and the water constantly stands within 25 to 30 feet of the top of the ground.

The North Dakota Coal Products Co. encountered water at 34 feet with their coal seam, one-half mile northeast of New Salem. A seven-foot coal stratum was found at this level and a thicker one was penetrated by a 65-foot well which was dug at the bottom of the shaft. The manager of the company, Mr. Affleck, gave the writer the freedom of the mine and kindly acted as escort for the party.

The following table shows the formations penetrated by the shaft, and their depth:

	Feet.
Soil	2
Yellow clay	10
White clay	12
Soapstone	3
Coal	7
White clay	5

The formation above the coal makes a good gallery roof.

The coal is a good quality of lignite, and the clay above and below is a good, clean commercial article.

SPRINGS.

Several townships have numerous living springs. Sweetbriar Creek and its tributaries in northern Morton County are largely fed by springs, and would soon go dry in summer but for them. Besides these a few of the many others noted belong to the following men north of New Salem: John Heid, Casper Bickel, P. Damman, J. Seethoff. Many sections, as numbers 3, 27, 33, 35, etc., in Twp. 140, R. 85, have from one to many springs, with good flow. The numerous springs about McKenzie, Burleigh County, and Crystal Springs, Kidder County, and in several other regions have been noted before. At McKenzie the water overflows the wells in a fair-sized area and the many springs at Crystal Springs give name to the town. The water in some of the springs tends to collect alkali in limited areas, making them worse than useless. Probably some of these have too high salt content to be available for application to soil with even the best management.

Conclusions as to Wells and Springs.—Many very large areas have a very low and inaccessible water table and a poor supply of water, but, from the tables given it is seen that within the area considered there must be a very large number of wells in which water stands so near the surface that it flows naturally or can be very cheaply pumped out. Many of these have a strong source of good water and are able to far exceed the needs of the live stock kept on the farms. In some localities the greater proportion of all wells yield an inexhaustible supply of water within 10 feet of the surface of the ground, in other localities within 18 feet, in others 25. Much of the spring water, most of the well water and, as the practice of a few pioneer operators of irrigation have demonstrated, the creeks, largely spring fed, are fully fit and can practically be applied to the land.

IRRIGATION POSSIBILITIES IN RIVERS AND CREEKS.

Extent of Irrigable Land.—The last report of the State Engineer indicates 1,540,000 acres of irrigable land in the state, 64,000 acres of which are now being irrigated, or are in preparation for it. Much of this land is in river valleys. Through the kindness of Mr. Atkinson, the writer has been able to bring down to date state statistics

Alfalfa Crop—Yegen irrigated farm near Bismarck.

and data used for comparison, on farms outside the area under special study. The number of water rights acquired in the state is about two hundred. All but forty-three were taken out before the passage of the irrigation code.

Federal Irrigation Projects.—The Missouri river traverses the area surveyed from north to south between Burleigh and Morton counties. The extensive project of the U. S. Reclamation Service for irrigating the valley of the Little Muddy and Missouri river flats at Williston is well known. This and the Yellowstone project now have areas under irrigation. Water is pumped from the Missouri to the Williston flats. A central power plant, burning lignite, furnishes power for this and the Buford Trenton plant. The first unit on each project was opened in 1908.

Other large federal projects on "bottom" lands along the Missouri, considered by irrigation authorities as being sufficiently extensive and having conditions favorable for irrigation projects, are (1) the Buford-Trenton flats along the Montana state line, 15,000 acres; (2) Nesson flats, 22,500 acres; (3) Fort Berthold Agency flats, 10,000 acres; (4) Old Fort Berthold flats, 10,000 acres; (5) Fort Stevenson flats, 20,000 acres; (6) Shell Creek project, 18,000 acres; (7) Independence, 5,300 acres; (8) Hancock, 7,000 acres; (9) Washburn, 10,000 acres; (10) Oliver, 7,000 acres; (11) Bowman, which is like that of the Yellowstone, a gravity project (one-third of its 10,000 acres lies in North Dakota); (12) Apple Creek flats, south of Bismarck (here 14,000 acres lie within the area under special study). Besides these large areas very many "bottoms" containing from 100 to 5,000 acres are found. The flats are usually in two "benches," the first about 20 feet, and the second 45 to 100 feet above the river. It is estimated that there is a total of 250,000 acres of land along the Missouri river which can be irrigated by pumping lifts of not exceeding 100 feet.[a]

The Yellowstone river has about 20,000 acres of flats below the 80-foot contour along the 15 miles of course in North Dakota before it enters the Missouri. The lower bench is but 10 feet above the river. Much of this area is irrigated by water diverted from the river by a dam at Glendive, Mont.

Missouri River Flats Within Area Surveyed.—The triangular area, south of Bismarck, in the angle made where the Apple joins

a. Atkinson Bulletin, 218 U. S. Agricultural Experiment Station.

the Missouri constitutes a terrace previously referred to. Seven thousand acres are on a wooded bench about 20 feet above the river, about 7,000 acres are 25 to 50 feet higher. Missouri river water can be readily pumped to the lower terrace, and Apple Creek could be made to flood both. In Kansas, Arizona and California water is often pumped 70 feet.

The meanderings of the river often cut the flats into small areas now on the east, now on the west side. These areas are often as large as 1,000 acres or more; the soil is good and the surface has the right slope for irrigation.

Private Enterprises Along the Missouri Tributaries.—Dozens of tributaries of the Missouri possess first and second bench flats, similar to, but on a smaller scale, than those of the master stream. Notably among these are the Cannon Ball, Heart, Sweetbriar and Apple within the special area; the Little Missouri, Big Muddy or Curlew, Little Muddy, Beaver, Shell, Green, and many others to the north.

Thus along the Missouri and its feeders are thousands of acres of land which will one day be artificially watered. Over one-third of this area can very easily be irrigated by flooding direct or with the minimum lift of 10 to 20 feet. Two-thirds of the "flat" area is within a cheap and practicable water lift.

Single farms have been successfully irrigated on the Missouri flats and those of its tributaries, instances of the latter being the Yegen farm on Apple Creek, the Headrich[a] ranch on the Big Muddy, the Rounsaville farm on the Little Muddy, the Erlrand Paulson farm on the Knife, the C. A. Patterson farm on the Spring Creek, and the Fisher Brothers' farm on the Green River.[b]

These single farm projects, largely used in other states, might be applied to much larger areas in the valleys mentioned and extended to numerous other creek valleys in the state. By comparison of the conditions holding in the valleys of such streams as the Heart, Sweetbriar, Cannon Ball and Apple with those of other rivers which are being irrigated, one is led to the belief in a good future for irrigating large tracts in some cases, and, at least a considerable area, even where the water supply is more limited. The water may be pumped directly from the larger streams or stored in reservoirs to be pumped up, in case the level is too high for leading the water

(a) Fourth Biennial Report N. D. Soil Survey, Williston area.
(b) A. G. Leonard, Lignite and its Relation to Irrigation.
Third Biennial Report, Geological Survey, N. D.
F. A. Wilder, Irrigation, Second Biennial Report, Geological Survey, N. D.

directly to the ditches by diversion dams. To instances already quoted for other areas within the state may be added such projects as that of Cache* Creek, Cal., where the conditions are very similar to those holding on the Missouri tributaries. Many farmers along Cache Creek have depended upon pumping water from the creek and from wells. These are found effective. Many of these are found below the Moore dam, and in July the creek is often but a succession of detached pools. Steam and gasoline engines pump this water to the land above.

Sweetbriar Creek.—The Sweetbriar rises in the southwestern part of Oliver County and soon emerges into Morton, where it flows diagonally across four townships, about 50 miles, and empties into the Heart river near Lyons. It has a drainage basin of 160,000 acres, 10,000 of which stand 10 to 20 feet above the creek, and are easily irrigable. Some of the richest land in Morton County is in its valley. Like most of the rivers and creeks of this region, it has two benches or terraces. The first is 10 to 15 feet and the second 30 to 40 feet above the channel floor. This terrace structure probably had a common origin in the swollen rivers of late glacial time, being followed by the diminutive streams of today. The present streams meander tortuously in very narrow channels, while the former greater volume cut more widely over the level of the first bench. This first terrace along the Sweetbriar, which is rarely more than one-half mile wide, is fertile and worthy of the best treatment. The natural precipitation, supplemented by a few wettings a season, would be quite sufficient. The valley is narrow enough in places for dam building. The creek dwindles to a small stream in mid-summer, but never goes dry, as it is fed largely by springs. These springs are rather numerous in the upland, even back from the creek in several townships.

These fertile uplands, which constitute the second bench, are worthy of receiving any water remaining above the requirements of the flats. However, the 30 to 40 feet lift would so increase the cost that it would be impracticable to install a plant unless there remained water considerably in excess of the needs of the bottoms. The lift to the flat is less than that to the irrigated Green river bottoms of similar character, where the 15-foot altitude is easily and cheaply surmounted. The lower flats of the Cannon Ball and other streams are but 10 feet above the water.

*Chandler. U. S. Water Supply and Irrigation Papers No. 45 p. 23. Bul. 207. Office U. S. Expt. Sta.

If alfalfa is properly irrigated it will yield five tons per acre in three cuttings after the first season.

Many irrigators are constructing retention dams in the coulees to catch the spring floods. This practically insures a crop for the season. A good example of this is the experience of Mr. H. W. House, Twp. 146, R. 84, who thus irrigated for wheat in March. This was followed by practically no rainfall the entire growing season, but the yield was over 25 bushels per acre. On the unirrigated land in the same field the crop was not worth cutting.

Mr. H. A. Nelson has lived in the Nesson valley twenty years and has been able to double or treble crop yields by the spring flooding system.

The following table of results, secured by a practical farmer on irrigated land, gives a convincing argument for the benefits of irrigation:

Crop	Irrigated Yield per acre	Unirrigated (a) Yield per acre
Wheat	32½ bu. No. 1	22 bu.
Oats	78 bu. No. 1	38 bu.
Hay	2 to 3 tons	¾ to 1¼ tons
Potatoes	190 bu.	90 bu.
Cabbage	38 pound heads	5 to 8 pound heads

The year these yields were made, 1892, was an exceptionally good year on unirrigated lands. A second flooding of potatoes in July raised the yield on such land to 360 bushels per acre.

The following data for crops of 1910 in another valley shows the contrast more sharply:

Crop	Irrigated once, yield per acre	Irrigated twice, yield per acre	Unirrigated, yield per acre
Wheat	30¼ bu.	36 bu.	9 bu.
Oats	76 bu	90 bu.	21 bu.
Hay	2 tons	3 tons	1 ton
Potatoes	195 bu.	340 bu.	60 bu.

The same general conclusion has been borne out by the Williston sub-station work of the past three years. While in 1908 but little data was collected, it was largely in favor of the irrigated areas. Nineteen hundred and nine was a successful year for dry farming methods, and the yields of small grain on irrigated land was not much in excess of those not irrigated, in that season. However,

a Bulletin 219 U. S. Dept. Agriculture p. 19.

several plots not irrigated in 1909 had been the previous year. It is hard to say just how much this fact and the close proximity of certain non-irrigated plots to those water-fed had to do with the large yields of those not irrigated. The results with potatoes and young alfalfa were decidedly in favor of irrigation. However, it is in such unfavorable years as that of 1910 that the marvelous possibilities of irrigation are seen.

Fall Irrigation.—At this and other experiment stations it is found very advisable to irrigate in the fall for the next season's crop, a good example of which was reported by Mr. Schollander at Williston the past season in a field of oats where a portion which had been irrigated late in 1909 yielded nearly twice as much per acre as the rest of the field, although the whole field was irrigated twice during the past growing season.

The value of fall irrigation depends entirely upon the subsequent treatment of the soil at the hands of the farmer. The moisture largely evaporates unless the surface is protected by a loose textured mulch, such as a dust blanket offers until the ground freezes.

Aside from the value of the extra supply of water held by the ground till the following spring, there are many other benefits to the soil of mechanical nature. The soil being moist when frost penetrates it has the soil particles disintegrated by freezing and thawing. The same process in the subsoil permits the roots to penetrate deeper. Much plant food is thus made available. Fall irrigation not only insures the possibility of fall plowing, but permits the plow to go down to a depth of eight inches with comparative ease and make still more condemnable the three-inch sod-scalping process.

Irrigation Methods.—Two methods of treatment of the water supply of creeks have been found practicable.

First.—Pumping direct from a reservoir made by a large dam across the creek, holding until summer the excess precipitation of the spring.

Second.—Diversion dams, by which snow water and spring rain are directed from the creek to the fields rather than stored up.

Comparatively inexpensive dams are constructed, and an ordinary farm engine is often used. As noted before, some farmers have formed small reservoirs by throwing a dam across a draw, retaining enough water to irrigate 15 to 25 acres.

The second method is made use of in the Little Muddy valley in Williams County, the Beaver Creek Valley in Billings County, and

in the area under consideration in such valleys as that of Apple creek. Thus no large amount of water is stored up. Reservoirs are also made along Apple creek, the little Muddy, and its tributaries, and here, as in other valleys, gasoline engines are used at a relatively small expense to elevate the water to the flats above, ten, twenty and more feet high.

It has been said on good authority* that for irrigation and other purposes water is cheaper pumped than delivered by gravity sources, even where fuel is scarce. This method is very cheap in the Missouri river system, where pumping stations can often be located at or near the mouth of lignite coal mines. Lignite is delivered at the pump down to one dollar per ton. When one beholds an eight-foot coal seam outcropping along the river bluff, he is impressed with the possibilities of cheap fuel. It is felt that the lignite, found along many of these streams may become an even greater source of power for pumping than it is at present. Farmers using lignite are found in such valleys as those of the Green and Little Heart rivers.

Windmills, more or less independable at all times, have however high efficiency for limited tracts, such as gardens, especially when reservoirs are used. They are more valuable on the upland, where the wind has free access, than in the river valleys, where the upper terraces or the bluffs shield them.

Windmills, with their storage tanks, costing $150 to $350, often have a capacity for irrigating 10 to 15 acres in the far west. These might be a great boon in Kidder County, where the wells are about the only extra source of water. They can be used to supplement river water in all areas.

Water Rights.—The North Dakota irrigation code, adopted by the legislature of 1905, is practically identical with that of several western states. A copy may be obtained free by dropping a postal to the state engineer.

To many the methods of securing water rights seem so complex and attended by so much red tape that they hesitate to seek to obtain its benefits. However, the appropriation is only attended with those necessary precautions which are deemed adequate to safeguard the interests of the public in general and the irrigator in particular. The disheartening delays of expensive litigation over water rights, obtained through imperfectly constructed codes of other states, have set back the proper devolepment of the country for decades. Knowledge of this led our lawmakers to be but duly cau-

*Wilson Irrigation Eng. p. 456.

tious. At this stage of the work the state is especially desirious of creating interest among farmers, leading to the development of our resources by this exceedingly important means and is, through the state engineer, and the directors of the state geological and soil economic surveys, anxious to make simple the process of acquiring and developing her water rights.

Investment.—True it is that the proper development of a large farm under irrigation methods requires the investment of at least a few hundred dollars. However, the rewards are so certain and so ample as to make it but a matter of good business acumen to so invest, if the money is at all available. On the other hand in such small projects as irrigation from springs, wells, dammed coulees, or from certain creeks where a small diversion dam is sufficient for spring flooding, the initial expense entailed in putting gardens or few acres under the beneficent effect of water, is but small, and is represented largely by work which the irrigator himself can perform. From a small beginning, the constructive work and areas irrigated can in many cases be slowly increased each year, until a large and remunerative project is established.

No previous experience in irrigation is necessary. With the advice of the state engineer or the expert federal irrigators within the state, the man of average intelligence can develop a small system on his own farm. The experiment sub-station at Williston, farms on Apple, Green and other rivers, with land under irrigation, are good object lessons to farmers within a limited radius.

Recommendation.—As other sites are selected for college demonstration farms and sub-stations, the writer heartily recommends that a good percentage of them be chosen in the various creek valleys of the state which are susceptible of being flooded. Within a very few years irrigation is destined to be extended to all these areas. Owners able and willing can be found who will make the necessary expenditure of money and time to make sufficient land ready for irrigation. The state engineer would lay out the irrigating system. The care and direction of the various details of the process of irrigating the land could be assumed by some competent member of the Agricultural College experiment station staff, as in the general farm management by the farm superintendent. These farms, as centers of influence may, by the example of carefully applied irrigation, show the farmers of these valleys the invaluable resources of their land, capable of development at moderate expense.

Irrigation dam across coulee on farm of Mr. H. W. House, Underwood, N. D. Mr. House has very successfully flooded 140 acres for several years. Snow water and spring rains are collected and distributed over fields. This acreage can be trippled. Mr. House's results with wheat, oats, flax and corn have been good as the following will prove:

	Bushels per acre Irrigated	Bushels per acre not Irrigated	Acreage
1908—Wheat ..	35	11	15
Oats	98	35	10
1909—Wheat ..	47½	13	70
Oats	137½	45	50
Corn	40	27	20

Hundreds of other farms have the same source of water which can just as cheaply be distributed. Mr. House sold $250 worth of vegetables besides raising for his own use. Potatoes yielded 320 bushels per acre.

SUMMARY.

Portions of three counties, Morton, Burleigh and Kidder, in the semi-arid section of the state, were studied as to water supply and it is found that:

1. Dry farming supplemented by artificial watering, in large areas where possible. will make the greater part of the region a fairly safe and reliable farming section.

2. The Soil Survey of two typical areas proved the soil to be rich, although the water table is low in certain large tracts.

3. While the water table is low in Kidder county as regards accessibility to crop roots, the level is generally high in respect to well sources here, as well as in the other two counties studied.

4. The flowing wells, many of the common wells, and the springs could, by wind or engine power, be made to irrigate considerable portions of the three counties.

5. A study of the adaptability of the Apple river flats of the Missouri to irrigation, indicates that about 14,000 acres of rich sandy loams can be made to bring large yields under very intensive farming, at the very suburbs of the state capital—the water to be pumped from the Missouri river and diverted by dams from Apple creek.

6. Following the methods in use in California, Kansas, and elsewhere, a dozen or more streams in Burleigh and Morton counties can be made to irrigate extensive areas of their terraces by (1) spring flooding or (2) pumping from reservoirs made by damming their valleys.

7. Irrigation is most applicable to the valleys of the Curlew, Apple, Sweetbriar, and Cannon Ball rivers, but very practicable in those of nearly all streams.

The Sweetbriar, as a type, has 10,000 acres of rich land but a few feet above the stream, and many thousands more 30 to 40 feet above the stream.

9. Lignite coal outcropping along the river banks, or within a short haul of pumping stations, makes a very cheap source of power for raising the water.

10. Actual crop production on the lands of the "pioneer" irrigation farmers has demonstrated that small grains, potatoes, hay, etc., are not only made certain crops, but that the yield is increased from 100 to 300 per cent.

REPORT ON THE PLANT SURVEY OF THE MORTON AREA IN MORTON COUNTY, NORTH DAKOTA.

BY W. B. BELL.

The Morton Area covered by the Soil and Biological Surveys during the summer of 1907 from June 21st to September 10th, comprises 544 square miles embracing 16 townships, viz.:

Townships 131 and 132 north and ranges 85 to 92 west inclusive.

The principal part of the area lies in southwestern Morton county, but includes a small portion of Hettinger and Adams counties.

For detailed account of the soil conditions here see the report of the "Soil Survey of the Morton Area, North Dakota," by Thomas D. Rice, issued by the United States Department of Agriculture, Bureau of Soils. The methods followed here and the objects sought were essentially those outlined in a previous report, vide: "Report of the Agricultural College Survey of North Dakota, 1907-8," p. 19.

Thanks are due to the director of the Agricultural and Economic Geological Survey of North Dakota and to the Northern Pacific Railway Co., for providing facilities which made this work possible through cooperation with the Biological Department of the North Dakota Agricultural College and Experiment Station.

The excellent work of Professor H. F. Bergman of this Department, to whom has fallen the arduous task of identifying the many thousands of plants collected and upon which this report is based, is here gratefully acknowledged.

SUBKINGDOM PTERIDOPHYTA.

ORDER 1. FILICALES.

FAMILY 5. POLYPODIACEAE.

Fern Family.

Pellaea atropurpurea (L) Link. Growing in crevices of sandstone ledges at top of hill.

Woodsia oregana D. C. Eaton. In crevices of sandstone rock at top and on sides of Coffin butte.

ORDER 2. SALVINIALES.

Family Marsileaceae.

Marsilea vestita Hook & Grey. Occasional on heavy clay soil in bottom of sloughs.

ORDER 3. EQUISETALES.

FAMILY 1. EQUISETACEAE.

Horsetail Family.

Equisetum hyemale L. Scouring Rush. Scattered commonly along cuts and sloughs over prairie.

ORDER 4. LYCOPODIALES.

FAMILY 2. SELAGINELLACEAE.

Selaginella densa Rydb. On heavy clay soil in Bad Lands at base of buttes.

SUBKINGDOM SPERMOPHYTA.

CLASS 1. GYMNOSPERMAE.

ORDER 1. PINALES.

FAMILY 1. PINACEAE.

Pine Family.

Juniperus virginiana L. Red Cedar. On clay banks along Snake Creek and over tops and sides of stony clay buttes.

CLASS 2. ANGIOSPERMAE.

SUB-CLASS 1. MONOCOTYLEDONES.

ORDER . PANDANALES.

FAMILY 2. SPARGANIACEAE.

Bur-reed Family.

Sparganium eurycarpum Engelm. Broad-fruited Bur-reed. In wet situations along borders of sloughs and streams.

ORDER 2. NAIDALES.

FAMILY 1. NAIADACEAE.

Potamogeton heterophyllus Schreb. Various-leaved Pondweed. Floating in water at bottom of Snake Creek.

Potamogeton foliosus Raf. Leafy Pondweed. Common in streams.

FAMILY 2. SCHEUCHZERIACEAE.

Arrow-grass Family.

Triglochin palustris L. Marsh Arrow-grass. In wet bog-like sloughs.

FAMILY 3. ALISMACEAE.

Water-Plantain Family.

Alisma plantago-aquatica L. Water Plantain. In shallow water on muddy bottom of Snake Creek.

Sagittaria latifolia Willd. Broad-leaved Arrow-head. In shallow water along banks of Snake creek.

ORDER 3. GRAMINALES.

FAMILY 1. GRAMINEAE.

Grass Family.

Andropogon scoparius Michx. Broom Beard-grass. Scattering on stony soil at base of low hills.

Andropogon furcatus Muhl. Forked Beard-grass. Common over rolling prairie ranging from shallow cuts to tops of high hills.

Panicum miliaceum L. Millet. An introduced grass found in fields and waste places.

Panicum virgatum L. Tall Smooth Panicum. In low, dry, or moist situations over rolling prairie.

Panicum wilcoxianum Vasey. Wilcox.'s Panicum. On dry sides of shallow cuts.

Chaetochloa viridis (L) Scribn. Green Fox-tail Grass. Occasional in waste places. Often becomes troublesome in fields when allowed to scatter. Should be rigidly controlled.

Phalaris arundinacea L. Reed Canary-grass. Growing in shallow water along Snake creek.

Aristida longiseta Steud. Long-awned Aristida. Abundant on dry, sandy hillsides. Important forage grass.

Stipa viridula Trin. Green Stipa. On dry, sandy soil between buttes, along banks and on hillsides.

Stipa comata Trin and Rupr. Western Stipa. Growing abundantly over dry, sandy valley of Cannon Ball river, ranging over the prairie and high up on sides of buttes. Forms from one-half to two-thirds of the grass in the Cannon Ball valley. A valuable hay and pasture grass but very troublesome to sheep, especially lambs, the pointed, barbed seeds causing serious injury to the throat.

Stipa spartea Trin. Porcupine-grass. Abundant along creeks, cuts, and on hillsides.

Eriocoma cuspidata Nutt. Silky Oryzopsis. On dry, sandy soil over rolling prairie, at base of dry bluffs and on top of buttes.

Muhlenbergia racemosa (Michx.) B. S. P. Marsh Muhlenbergia. Among low, dense shrubs on north side of Pretty Rock butte.

Sporobolus brevifolius (Nutt) Nash. Short-leaved Rush-grass. Along bottom of shallow cut on rolling prairie.

Calamagrostis inexpansa A. Gray. In cuts between hills.

Calamgrostis hyperborea Lange. Along shallow cuts.

Calamovilfa longifolia (Hook) Hack. Long-leaved Reed-grass. Abundant on dry, sandy soil, especially in the western part of the area. A good sand-binding grass.

Agrostis hyemalis (Walt) B. S. P. Rough Hair-grass. Abundant in low situations between hills.

Spartina cynosuroides (L) Willd. Tall Marsh Grass. Common in moist situations along cuts, sloughs and pools.

Spartina gracilis Trin. Inland Cord-grass. In woods along banks of Cannon Ball river, in dry cuts in rolling prairie and along low alkaline sloughs.

Schedonnardus paniculatus (Nutt) Trelease. Schedonnardus. On low, moist ground and along banks of sloughs in rolling prairie.

Bouteloua oligostachya (Nutt) Torr. Grama-grass. Mesquite-grass. Abundant throughout the area over valley, hillside, prairie and among buttes. Growing well on sandy and gravelly soils. A valuable pasture grass.

Atheropogon curtipendulus (Michx) Fourn. Racemed Bouteloua. Abundant over dry, stony and gravelly hillsides. An excellent pasture grass.

Beckmannia erucaeformis (L) Host. Beckmannia. Common in moist situations over bottom of sloughs and along banks of streams.

Bulbilis dactyloides (Nutt) Raf. Buffalo-grass. Abundant over the Cannon Ball valley and common over the prairie, on stony hillsides and among sage and cactus on dry, heavy clay soil. One of the most valuable western pasture grasses.

Koeleria cristata (L) Pers. Koeleria. One of the principal grasses of the area, growing abundantly over valley, hillside and prairie, thriving on dry, sandy, gravelly and stony soil. A good hay and forage grass.

Distichlis spicata (L) Greene. Marsh Spike-grass. Common on sandy, alkaline soils over the prairie and among buttes.

Poa flava L. False Red-top. Abundant along small creeks tributary to Cannon Ball river in heavy clay soil.

Poa pratensis L. Kentucky Blue-grass. Occasional along shallow cuts on hillsides of prairie.

Poa arida Vasey. Prairie Spear-grass. Growing on dry, stony hillsides, at top of buttes, in alkaline muck at edge of Sand Lake and on sandy soil over Cannon Ball valley.

Panicularia americana (Torr) Mac M. Reed Meadow-grass. Abundant in wet situations by pools and streams.

Panicularia borealis Nash. Slender Manna-grass. Growing in shallow water along Snake creek and other streams.

Festuca octoflora Walt. Slender Fescue-grass. Common on dry, sandy soil in Cannon Ball valley, prairie and among buttes.

Agropyron richardsonii Schrad. Growing commonly in slight depressions on open prairie, along banks of streams and on hillsides.

Agropyron tenerum Vasey. Slender Wheat-grass. Common along dry banks of cuts and creeks and over dry clay slough bottoms.

Agropyron spicatum (Pursh) Scribn. & Sm. On sandy soil, among buttes. Abundant on gravelly hillsides of rolling prairie.

Agropyron dasystachyum (Hook) Vasey. Northern Wheat-grass. Abundant on dry, stony and gravelly hillsides, and occasional on sides of clay buttes.

Agropyron pseudorepens. Scribn. & Sm. False Couch-grass. Common in moist situations in Cannon Ball valley and surrounding prairie.

Hordeum jubatum L. Squirrel-tail grass. Common in dry, alkaline cuts and sloughs. A serious pest when introduced into fields.

Elymus virginicus L. Terrell-grass, Virginia Wild Rye. Scattering among shrubbery along banks of Cannon Ball river.

Elymus macounii Vasey. Macoun's Wild Rye. Scattering along banks of Snake creek.

Elymus brachystachys Scrib. & Ball. Abundant along streams and cuts.

FAMILY 2. CYPERACEAE.

Sedge Family.

Eleocharis palustris (L) R. & S. Creeping Spike-rush. Common over bottom of sloughs.

Eleocharis acicularis (L) R. & S. Needle Spike-rush. Growing in water and along the edge of streams and pools and on moist, sandy soil, among buttes.

Scirpus fluviatilis (Torr) A. Gray. River Bulrush. Abundant over bottom of sloughs and in shallow water along streams.

Carex aristata R. Br. Awned Sedge. Common in sloughs.

Carex vulpinoidea Michx. Fox Sedge. In low, wet meadows.

Carex muhlenbergii Schk. Muhlenberg's Sedge. Along banks of Snake creek.

ORDER 7. XYRIDALES.

FAMILY 5. COMMELINACEAE.

Spiderwort Family.

Tradescantia bracteata Small. Long-bracted Spiderwort. Abundant on dry, sandy soil in Cannon Ball valley and on prairie.

Tradescantia occidentalis Britton. Western Spiderwort. Common on very sandy soil in cuts, along banks of streams and among buttes in Bad Lands.

ORDER 8. LILIALES.

FAMILY 2. MELANTHACEAE.

Bunch-flower Family.

Zygadenus elegans Pursh. Glaucous Zygadenus. On low, moist ground bordering sloughs.

FAMILY 3. LILIACEAE.

Lily Family.

Allium reticulatum Don. Fraser's Wild Onion. Abundant on sandy soil, among Cannon Ball river and among buttes, thriving where little but sage-brush and cactus grow. A suggestion that suitable varieties of onions may prove profitable upon such soil.

Yucca glauca Nutt. Bear Grass. Abundant on sides and tops of high, stony hills bordering Cannon Ball valley.

FAMILY 4. CONVALLARIACEAE.

Lily-of-the-Valley Family.

Vagnera stellata (L) Morong. Star-flowered Solomon's Seal. Common among woods along banks of Cannon Ball river.

Salomonia commutata (R. & S.) Britton. Smooth Solomon's Seal. Frequent in woods bordering banks of Cannon Ball river and occasional on high, dry, stony banks of wooded cuts.

FAMILY 5. SMILACEAE.

Smilax Family.

Nemexia pulverulenta (Michx.) Small. Hairy Carrion Flower. In sandy alluvial soil among woods by Cannon Ball river.

FAMILY 9. IRIDACEAE.

Iris Family.

Sisyrinchium angustifolium Michx. Common on coarse, gravelly soil on hillsides and along moist cuts.

FAMILY 17. JUNCACEAE.

Rush Family.

Juncus balticus Willd. Baltic Rush. Along cut between hills.

Juncus interior Wieg. Slender Rush. Along bottom of dry, shallow cuts in rolling prairie and in dry sloughs.

SUBCLASS 2. DICOTYLEDONES.

SERIES 1. CHORIPETALAE.

ORDER 3. SALICALES.

FAMILY 1. SALICACEAE.

Willow Family.

Populus tremuloides Michx. American Aspen. Occasional along cuts in rolling prairie.

Salix amygdaloides Anders. Peach-leaved Willow. Common along banks of Cannon Ball river and its tributaries.

Salix interior Rowlee. Sand-bar Willow. On sandy soil along streams and pools.

ORDER 9. URTICALES.

FAMILY 1. ULMACEAE.

Elm Family.

Ulmus americana L. American White or Water Elm. Common along the Cannon Ball river and its branches.

FAMILY 2. MORACEAE.

Mulberry Family.

Humulus lupulus L. Hop. Abundant on north side of Pretty Rock butte.

FAMILY 5. URTICACEAE.

Nettle Family.

Urtica gracilis Ait. Slender Nettle. On sides of buttes and cuts

Parietaria pennsylvanica Muhl. Pennsylvania Pellitory. Among brush in deep cut in side of butte and in crevices between sandstone ledges on Coffin butte.

ORDER 11. SANTALALES.

FAMILY 2. SANTALACEAE.

Sandalwood Family.

Comandra pallida A. D. C. Pale Comandra. On stony hilltops.

ORDER 13. POLYGONALES.

FAMILY 1. POLYGONACEAE.

Buckwheat Family.

Eriogonum flavum Nutt. Yellow Eriogonum. On dry, stony soil on top of buttes and hillsides.

Eriogonum multiceps Nees. Branched Eriogonum. On top of buttes on stony soil.

Eriogonum annuum Nutt. Annual Eriogonum. On dry, sandy hillsides of rolling prairie.

Rumex salicifolius Weinm. White, Pale or Willow-leaved Dock. In cut on sandy flats and at base of bluffs along Cannon Ball valley and in bottom of sloughs, dry at this season.

Polygonum emersum (Michx.) Britton. Swamp Persicaria. In sloughs.

Polygonum lapathifolium L. Dock-leaved or Pale Persicaria. On sandy soil at head of deep wooded cuts on sides of buttes.

Polygonum ramosissimum Michx. Bushy Knotweed. On alkaline soil along beds of sloughs and banks of streams.

Polygonum scandens L. Climbing False Buckwheat. Scattering among shrubbery along streams.

ORDER 14. CHENOPODIALES.

FAMILY 1. CHENOPODIACEAE.

Goosefoot Family.

Chenopodium album L. Lamb's Quarters. White Goosefoot. Pigweed. Common throughout the area over valley, prairie, hillside, and among buttes.

Chenopodium glaucum L. Oak-leaved Goosefoot. On sandy soil at margin of alkali lakes and on heavy clay soil at base of buttes.

Chenepodium leptophyllum (Moq.) Nutt. Narrow-leaved Goosefoot. On dry, gravelly soil of rolling prairie.

Chenopodium fremontii S. Wats. Fremont's Goosefoot. Among woods at head of cuts in sides of buttes.

Chenopodium hybridum L. Maple-leaved Goosefoot. In thicket at head of deep cut in butte.

Chenopodium rubrum L. Red Goosefoot. In bed of alkaline slough in sandy, rolling prairie.

Monolepsis nuttalliana (R. & S.) Greene. Monolepsis. On sandy hillside of rolling prairie.

Atriplex hastata L. Halberd-leaved Orache. In edge of small creek.

Atriplex nuttallii S. Wats. Nuttall's Atriplex. On dry, sandy, gravelly and stony soil of open rolling prairie.

Atriplex canescens (Pursh) James. Bushy Atriplex. On sides of dry, sandy bluffs.

Dondia depressa (Pursh) Britton. Western Blite. Common at margin of alkaline lakes.

Salsola tragus L. Russian Thistle. A troublesome weed on light, sandy soils.

FAMILY 2. AMARANTHACEAE.

Amaranth Family.

Amaranthus retroflexus L. Rough Pigweed. Along fire-guards and trails. A troublesome introduced weed.

Amaranthus graecizans L. Tumble-weed. An introduced weed ranging throughout the area.

FAMILY 4. NYCTAGINACEAE.

Four-o'clock Family.

Allionia nyctaginea Michx. Heart-leaved Umbrella-wort. Common on sandy soil in Cannon Ball valley, among woods, along its banks and along wooded cuts in sides of buttes.

Allionia hirsuta Pursh. Hairy Umbrella-wort. On dry, sandy hillsides of open rolling prairie.

Allionia linearis Pursh. Narrow-leaved Umbrella-wort. Ranging on dry clay or sandy soil from valleys and cuts to tops of hills and far up on clay sides of buttes.

FAMILY 6. PORTULACACEAE.

Purslane Family.

Talinum parviflorum Nutt. Small-flowered Talinum. On heavy clay and on sandy soil. Some on moist, some on very dry ground.

FAMILY 7. CARYOPHYLLACEAE.

Pink Family.

Agrostemma githago L. Corn Cockle. An exceedingly injurious introduced weed which is getting started in several fields here.

Silene antirrhina L. Sleepy Catchfly. On sandy soil in Cannon Ball valley and among buttes in Bad Lands.

Lychnis drummondi (Hook) S. Wats. Drummond's Pink. Along depressions between hills in rolling prairie.

Vaccaria vaccaria (L) Britton. Cow Herb. A noxious weed being introduced here in cultivated fields.

Cerastium vulgatum L. Larger Mouse-ear Chickweed. Occasional along shallow cuts over prairie.

ORDER 15. RANALES.

FAMILY 5. RANUNCULACEAE.

Crow-foot Family.

Anemone cylindrica A. Gray. Long-fruited Anemone. Along banks of cuts over prairie.

Anemone canadensis L. Canada Anemone. Common among shrubbery along banks of streams and cuts.

Clematis ligusticifolia Nutt. Western Virgin's Bower. Climbing on bushes and trees along banks of Cannon Ball river.

Ranunculus sceleratus L. Celery-leaved or Ditch Crow-foot. In slough at base of hills.

Ranunculus macounii Britton. Macoun's Buttercup. In moist or wet situations in cuts and along streams.

Batrachium trichophyllum (Chaix) Bossch. White Water-Crowfoot. Abundant in streams and pools, sometimes on wet banks.

Oxygraphis cymbalaria (Pursh) Prantl. Seaside Crowfoot. Growing abundantly in water and along the edge of streams and pools.

Thalictrum dasycarpum Fisch & Lall. Along moist banks of Snake creek.

Thalictrum purpurascens L. Purplish Meadow-rue. Abundant in woods along Cannon Ball river and its tributaries.

ORDER 16. PAPAVERALES.

FAMILY 1. PAPAVERACEAE.

Poppy Family.

Capnoides aureum (Willd) Kuntze. Golden Corydalis. On sandy banks of deep wooded cut on side of butte.

FAMILY 2. CRUCIFERAE.

Mustard Family.

Lepidium intermedium Gray. Pepper-grass. On cultivated silt loam and scattering over valleys.

Brassica juncea (L) Cosson. Indian Mustard. Occasional about stable yards and cultivated fields.

Roripa sinuata (Nutt) A. S. Hitchcock. Spreading Yellow-cress. In shallow cut on high flat land bordering Cannon Ball valley.

Roripa palustris (L) Bess. Marsh or Yellow Water-cress. In edge of water in small pools.

Lesquerella argentea (Pursh) MacM. Silvery Bladder-pod. On sandy soil in Cannon Ball valley.

Camelina sativa (L) Crantz. Gold-of-Pleasure. False Flax. Occasional over prairie. An introduced weed exceedingly troublesome in flax fields.

Sophia pinnata (Walt) Britton. Tansy Mustard. Occasional along banks of Snake creek.

Arabis hirsuta (L) Scop. Hairy Rock-cress. In woods along banks of Cannon Ball river and in low situations over valley and prairie.

Arabis holboellii Hornem. Holboell's Rock-cress. On sandy soil in Cannon Ball valley.

Erysimum cheiranthoides L. Worm-seed or Treacle Mustard. Along banks of streams and pools and in woods.

Erysimum inconspicuum (S. Wats) MacM. Small Erysimum. In sandy soil in Cannon Ball valley and dry banks of streams and cuts.

Erysimum asperum D. C. Western Wall-flower. Common over sandy valleys and ranging over sandy and stony prairie and hillsides.

FAMILY 3. CAPPARIDACEAE.

Caper Family.

Cleome serrulata Pursh. Pink Cleome. Occasional on banks of streams.

ORDER 18. ROSALES.

FAMILY 5. SAXIFRAGACEAE.

Saxifrage Family.

Heuchera hispida Pursh. Rough Heuchera. Growing on steep, stony hillsides.

FAMILY 8. GROSSULARIACEAE.

Gooseberry Family.

Ribes aureum Pursh. Golden, Buffalo or Missouri Currant. Common among woods along streams and on sides of buttes.

FAMILY 11. ROSACEAE.

Rose Family.

Drymocallis arguta (Pursh) Rydb. Tall or Glandular Cinquefoil In sandy depressions and on stony hillsides.

Potentilla sulphurea Lam. Rough-fruited Cinquefoil. Along shallow, grassy cut between hills.

Potentilla monspeliensis L. Rough Cinquefoil. Occasional along dry, shallow cuts among hills.

Potentilla bipinnatifida Dougl. Cut-leaved Cinquefoil. On sandy soil in Cannon Ball valley and on stony hillsides.

Geum macrophyllum Willd. Large-leaved Avens. Among shrubbery on sides of buttes.

Agrimonia hirsuta (Muhl) Bicknell. Tall Hairy Agrimony. Along banks of shallow, grassy cuts in the sides of buttes.

Rosa arkansana Porter. Arkansas Rose. On sandy soil in Cannon Ball valley and along cuts.

FAMILY 12. POMACEAE.

Apple Family.

Amelanchier alnifolia Nutt. Northwestern June or Service Berry. A valuable native berry found abundantly along the Cannon Ball river and its tributaries.

FAMILY 17. PAPILIONACEAE.

Pea Family.

Thermopsis rhombifolia (Nutt) Richards. Prairie Thermopsis. On sandy and stony soil on hilltops of rolling prairie.

Lupinus argenteus Pursh. Silvery Lupine. Abundant on gravelly and stony soil of open rolling prairie.

Lupinus pusillus Pursh. Low Lupine. Abundant on sandy soil in Cannon Ball valley, on stony hillsides and ranging down on sandy areas at their base. On sandy soil between buttes.

Lotus americanus (Nutt) Bisch. Prairie Bird's-foot Trefoil. Abundant on sandy soil over valleys, among buttes and on hillsides of open prairie.

Psoralea argophylla Pursh. Silver-leaf Psoralea. Common on sandy soil among buttes and abundant everywhere over valleys, hillsides and prairie.

Psoralea esculenta Pursh. Pomme Blanche. Prairie Apple or Turnip. Common on dry, sandy, gravelly and stony soil on hillsides and hilltops. Has a large edible root.

Amorpha nana Nutt. Fragrant False Indigo. On dry, stony hillsides.

Amorpha canescens Pursh. Leadplant. Shoe-strings. About the head of cuts on dry, stony hillsides.

Parosela enneandra (Nutt) Britton. Slender Parosela. At base of high, stony butte.

Kuhnistera oligophylla (Torr) Heller. Slender White Prairie-clover. On sandy soil among buttes and on dry, sandy and stony hillsides and hilltops of rolling prairie.

Kuhnistera purpurea (Vent) MacM. Violet Prairie-clover. Abundant on sandy and stony soil of hillsides and hilltops, along shallow cuts and open prairie.

Astragalus crassicarpus Nutt. Ground Plum. Found commonly on sandy hillsides. Growing in unusual abundance and luxuriance on low, sandy soil, on Sections 23 and 24 of Township 132, Range 86. The fruit of this plant is large and edible and might repay cultivation

Astragalus plattensis Nutt. Platte Milk Vetch. On sandy flats in Cannon Ball valley, among buttes and on hillsides.

Astragalus carolinianus L. Carolina Milk Vetch. Along banks of streams.

Astragalus adsurgens Pall. Ascending Milk Vetch. Common on dry, sandy prairie, and on clay and sandy hillsides and ranging over stony hilltops.

Astragalus hypoglottis L. Purple Milk Vetch. Along grassy, shallow cuts among hills.

Astragalus racemosus Pursh, Racemose Milk Vetch. Growing in large, dense tufts over open prairie, hillsides, banks and bluffs.

Astragalus bisulcatus (Hook) A. Gray. Two-grooved Milk Vetch. On sandy soil among buttes.

Astragalus lotiflorus. Hook. Low Milk Vetch. On sandy soil in Cannon Ball valley and on stony hillsides of rolling prairie.

Astragalus missouriensis. Nutt. Missouri Milk Vetch. Occasional on dry, stony hillsides of prairie and on sandy soil in Cannon Ball valley.

Homalobus tenellus (Pursh) Britton. Loose-flowered Milk Vetch. On side of high hill.

Aragallus lambertii (Pursh) Greene. Stemless Loco-weed or Crazy-weed. Abundant throughout the area in Cannon Ball valley over hillsides, bluffs and open prairie. A poisonous plant which causes "loco" in horses and cattle.

Aragallus patens Rydb. In sandy soil in Cannon Ball valley.

Glycyrrhiza lepidota Pursh. Wild Liquorice. Common along banks of cuts and streams and on stony hillsides.

Vicia linearis (Nutt) Greene. Narrow-leaved American Vetch. Abundant in valleys and over prairie and ranging to the top of high buttes.

Strophostyles pauciflora (Benth) S. Wats. Small Wild Bean. Along gravelly and stony banks of small streams and in edge of shrubbery along banks of Cannon Ball river.

ORDER 19. GERANIALES.

FAMILY 1. GERANIACEAE.

Geranium Family.

Geranium carolinianum L. Carolina Crane's-bill. On sandy soil among buttes.

Geranium bicknellii Britton. Bicknell's Crane's-bill. In moist cuts on hillsides.

FAMILY 2. OXALIDACEAE.

Wood-sorrel Family.

Oxalis stricta L. Upright Yellow Wood-sorrel. On moist banks of cuts.

Oxalis Cymosa, Small. Tall Yellow Wood-sorrel. Among woods along streams and on sides of buttes.

FAMILY 3. LINACEAE.

Flax Family.

Linum lewisii Pursh. Lewis' Wild Flax. Occasional along shallow, grassy cuts, in rolling prairie.

Linum sulcatum Riddell. Grooved Yellow Flax. On dry, sandy and gravelly soil of rolling prairie.

Linum rigidum Pursh. Large-flowered Yellow Flax. Common in sandy valleys and over prairie.

FAMILY 7. POLYGALACEAE.

Milkwort Family.

Polygala verticillata L. Whorled Milkwort. Occasional on sandy banks.

Polygala alba Nutt. White Milkwort. Abundant on dry, sandy, gravelly and stony hillsides and hilltops and occasional in Cannon Ball valley.

ORDER 20. SPINDALES.

FAMILY 4. ANACARDIACEAE.

Sumac Family.

Rhus trilobata Nutt. Ill-scented Sumac. Skunk-bush. On side of clay bluffs along Snake creek.

Rhus radicans L. Poison Ivy, Poison Oak. Common in thickets along streams and sides of hills and buttes.

FAMILY 9. ACERACEAE.

Maple Family.

Acer negundo L. Box Elder. Along cuts and streams.

ORDER 21. RHAMNALES.

FAMILY 2. VITACEAE.

Grape Family.

Vitis vulpina L. Riverside or Sweet-scented Grape. In woods along banks of cuts and streams.

ORDER 22. MALVALES.

FAMILY 2. MALVACEAE.

Mallow Family.

Malvastrum coccineum (Pursh) A. Gray. Red False Mallow. Abundant over valley, hillsides, prairie and among buttes in Bad Lands. Common along trails.

Hibiscus trionum L. Bladder Ketmia. Flower-of-an-hour. In small valley near Pretty Rock butte.

ORDER 23. PARIETALES.

FAMILY 5. VIOLACEAE.

Violet Family.

Viola canadensis L. Canada Violet. Common among woods along Cannon Ball river.

ORDER 24. OPUNTIALES.

FAMILY 1. CACTACEAE.

Cactus Family.

Opuntia polyacantha Haw. Many-spined Opuntia. Common on dry, sandy areas in Cannon Ball valley and over prairie.

ORDER 25. THYMELEALES.

FAMILY 2. ELAEAGNACEAE.

Oleaster Family.

Lepargyraea argentea (Nutt) Greene. Buffalo Berry. Common along banks of streams and high, stony bluffs.

ORDER 26. MYRTALES.

FAMILY 3. ONAGRACEAE.

Evening-primrose Family.

Epilobium paniculatum Nutt. Panicled Willow-herb. Scattered over bed of moist sloughs on rolling prairie.

Epilobium adenocaulon Haussk. Northern Willow-herb. Along bottom of deep cuts in open rolling prairie and in sides of buttes.

Onagra biennis (L) Scop. Common Evening Primrose. Night Willow-herb. Common on sandy and gravelly banks of streams and cuts in sides of hills and buttes.

Anogra albicaulis (Pursh) Britton. Prairie Evening-primrose. Common over valleys, hillsides and open prairie.

Anogra pallida (Lindl) Britton. White-stemmed Evening-primrose. Common on gravelly and sandy soil of valleys and rolling prairie.

Pachylophus caespitosa (Nutt) Raimann. Scapose Primrose. Occasional on sandy soil of open prairie.

Meriolix serrulata (Nutt) Walp. Tooth-leaved Primrose. Common on dry, sandy, gravelly and stony banks and hillsides.

Gaura coccinea Pursh. Scarlet Gaura. Abundant on sandy, gravelly and stony soil of valley hillsides and open prairie.

ORDER 26. MYRTALES.

FAMILY 5. HALORAGIDACEAE.

Water-milfoil Family.

Myriophyllum spicatum L. Spiked Water-milfoil. In deep pools and streams.

ORDER 27. UMBELLALES.

FAMILY 2. UMBELLIFERAE.

Carrot Family.

Musineon divaricatum (Pursh) Nutt. Leafy Musineon. Scattered over Cannon Ball valley.

Cicuta maculata L. Water Hemlock. Scattered in sloughs and pools. This highly poisonous plant has caused the death of many cattle.

Sium cicutaefolium Gmel. Hemlock Water-parsnip. Common with the preceding species and often mistaken for it.

Heracleum lanatum Michx. Cow-parsnip. Scattered in thickets along streams and cuts.

FAMILY 3. CORNACEAE.

Dogwood Family.

Cornus stolonifera Michx. Red-Osier. Cornel or Dogwood. Frequent along banks of Cannon Ball river.

SERIES 2. GAMOPETALAE.

ORDER 2. PRIMULALES.

FAMILY 1. PRIMULACEAE.

Primrose Family.

Steironema ciliatum (L) Raf. Fringed Loosestrife. Common along moist cuts.

ORDER 4. GENTIANALES.

FAMILY 1. OLEACEAE.

Olive Family.

Fraxinus lanceolata Borck. Green Ash. Common along banks of Cannon Ball river and its tributaries.

FAMILY 5. APOCYNACEAE.

Dogbane Family.

Apocynum cannabinum L. Indian Hemp. Amy-root. Common along bottom of cuts.

FAMILY 6. ASCLEPIADACEAE.

Milkweed Family.

Asclepias verticillata L. Whorled Milkweed. Common on dry stony hillsides.

Acerates viridiflora (Raf) Eaton. Green Milkweed. Common on dry, stony hillsides and hilltops of open rolling prairie.

ORDER 5. POLEMONIALES.

FAMILY 1. CONVOLVULACEAE.

Morning-glory Family.

Convolvulus sepium L. Hedge or Great Bind-weed. Rutland Beauty. Common among woods along banks of streams and occasional in wooded situations on sides of buttes.

FAMILY 3. POLEMONIACEAE.

Phlox Family.

Phlox hoodii Richards. Hood's Phlox. Common on stony and gravelly soils over hillsides and prairie and on top of high, stony buttes.

Phlox douglasii Hook. Douglas' Phlox. Occasional on dry, gravelly soil.

Collomia linearis Nutt. Narrow-leaved Collomia. Common in moist situations along banks of cuts and streams, sometimes among woods.

Navarretia minima Nutt. Small Navarretia. On dry, heavy clay in depression in sandy prairie.

FAMILY 4. HYDROPHYLLACEAE.

Water-leaf Family.

Macrocalyx nyctelea (L) Kuntze. Nyctelea. Abundant on sandy soil in Cannon Ball valley.

FAMILY 5. BORAGINACEAE.

Borage Family.

Lappula texana (Scheele) Britton. Hairy Stickseed. In dry, sandy soil of Cannon Ball valley.

Lappula americana (A. Gray) Rydberg. Nodding Stickseed. Common among thickets and woods along banks of streams.

Allocarya scopulorum Green. Mountain Allocarya. On heavy, dry, clay soil.

Oreocarya glomerata (Pursh) Greene. Clustered Oreocarya. In dry, stony soil, on top of hills bordering the Cannon Ball valley.

Lithospermum linearifolium Goldie. Narrow-leaved Puccoon. In dry, gravelly, and stony soil on hillsides.

Onosmodium molle Michx. Soft-hairy False Gromwell. Along sides of shallow grassy cuts over the open rolling prairie.

FAMILY 6. VERBENACEAE.

Verbain Family.

Verbena hastata L. Blue Verbain. Wild Hyssop. Along moist banks of deep cuts and creeks.

Verbena bracteosa Michx. Large-bracted Verbain. On heavy clay and sandy soil over valleys and prairie.

FAMILY 7. LABIATAE.

Mint Family.

Agastache anethiodora (Nutt) Britton. Fragrant Giant-hyssop. Scattered over sandy prairie.

Monarda fistulosa L. Wild Bergamot. In thickets on sides of hills and buttes.

Hedeoma hispida Pursh. Rough Pennyroyal. On dry clay and gravelly soil usually along cuts or in low situations.

Lycopus americanus Muhl. Cut-leaved Water Hoarhound. Along moist, stony or gravelly banks.

Lycopus lucidus Turcz. Western Water Hoarhound. About edges of streams and pools.

Mentha canadensis L. American Wild Mint. In moist situations along banks of streams and bottom of cuts.

FAMILY 8. SOLANACEAE.

Potato Family.

Physalis virginiana Mill. Virginia Ground-cherry. Common among shrubbery along banks of streams and in cuts among hills.

Physalis heterophylla Nees. Clammy Ground-cherry. On sandy, alluvial soil in Cannon Ball valley.

Solanum triflorum Nutt. Cut-leaved Nightshade. Occasional on heavy clay soil.

Solanum rostratum Dunol. Sand-bur. Beaked Nightshade. On sandy soil of open prairie. Grows abundantly along sandy fireguards and may become a troublesome weed in cultivated fields.

FAMILY 9. SCROPHULARIACEAE.

Figwort Family.

Pentstemon albidus Nutt. White-flowered Beard Tongue. On sandy soil in Cannon Ball valley.

Pentstemon gracilis Nutt. Slender Beard Tongue. Abundant on sandy and gravelly soil of Cannon Ball valley and surrounding prairie.

Pentstemon grandiflorus Nutt. Large-flowered Beard Tongue. Common over valley, hillsides and open prairie on sandy soil.

Pentstemon acuminatus Dougl. Sharp-leaved Beard Tongue. Abundant on gravelly and stony soil over hillsides and valleys.

Monniera rotundifolia Michx. Round-leaved Hedge-hyssop. On heavy clay soil at bottom of sloughs.

Gratiola virginiana L. Clammy Hedge-hyssop. On wet soil by edge of pools and sloughs.

Veronica peregrina L. Purslane Speedwell. Neckweed. On moist, heavy, clay soil in bottom of sloughs.

Castilleja sessiliflora Pursh. Downy Painted-cup. In dry, stony soil at top of high hills.

Orthocarpus luteus Nutt. Yellow Orthocarpus. In low situations on open rolling prairie.

FAMILY 10. LENTIBULARIACEAE.

Bladderwort Family.

Utricularia vulgaris L. Greater Bladderwort. Common in sloughs, pools and sluggish streams.

FAMILY 11. OROBANCHACEAE.

Broom-rape Family.

Thalesia fasciculata (Nutt) Britton. Clustered or Yellow Cancer-root. On sandy loam of open prairie and on stony ground at top of Pretty Rock butte.

ORDER 6. PLANTAGINALES.

FAMILY 1. PLANTAGINACEAE.

Plantain Family.

Plantago major L. Common or Greater Plantain. On banks of Snake creek in waste places. Troublesome in lawns and gardens.

Plantago purshii R. & S. Pursh's Plantain. Abundant on sandy and gravelly soils among buttes and over the prairie. A troublesome weed on cultivated land.

ORDER 7. RUBIALES.

FAMILY 1. RUBIACEAE.

Madder Family.

Galium boreale L. Northern Bedstraw. Frequent among thickets along streams and cuts and on stony sides of buttes.

FAMILY 2. CAPRIFOLIACEAE.

Honeysuckle Family.

Symphoricarpos occidentalis Hook. Wolfberry. Abundant on rich loam soil along banks of streams and cuts.

ORDER 9. CAMPANULALES.

FAMILY 2. CAMPANULACEAE.

Bell-flower Family.

Campanula rotundifolia L. Harebell. Blue Bells of Scotland. Abundant along shallow, grassy cuts, scattering over rolling prairie and on stony ledges at top of hills.

Specularia perfoliata (L) A. DC. Venus' Looking-glass. Scattered in slight depressions in sandy soil among buttes.

FAMILY 3. CICHORIACEAE.

Chicory Family.

Lactuca pulchella (Pursh) D. C. Large-flowered Blue Lettuce. Among woods along banks of streams and on hillsides.

Lygodesmia juncea (Pursh) D. Don. Rush-like Lygodesmia. Common on sandy soil. A troublesome perennial weed in cultivated fields especially in the light, sandy areas.

Agoseris glauca (Pursh) Greene. Large-flowered Agoseris. Growing in moist cuts and depressions.

Crepis runcinata (James) T. & G. Naked-stemmed Hawksbeard. In low, moist ground bordering sloughs and along shallow, grassy cuts among hills.

ORDER 9. CAMPANULALES.

FAMILY 4. AMBROSIACEAE.

Ragweed Family.

Iva xanthiifolia (Fresen) Nutt. Burweed Marsh Elder. Scattered along cuts and banks of streams. A troublesome weed in grain fields.

Ambrosia trifida L. Horse-cane, Bitter-weed, Great Ragweed, Kinghead. Scattered occasionally along cuts. A noxious weed in grain fields.

Ambrosia artemisiaefolia L. Ragweed, Roman Wormwood. Scattered along cuts over Cannon Ball valley and on prairie. A weed in waste places and fields.

Ambrosia psilostachya D. C. Western Ragweed. In moist soil along banks of Cannon Ball river.

Xanthium canadense Mill. American Cocklebur. Along banks of Cannon Ball river. A troublesome weed in pastures and cultivated fields.

FAMILY 5. COMPOSITAE.

Thistle Family.

Kuhnia glutinosa Ell. Prairie False Boneset. On dry, sandy soil.

Lacinaria punctata (Hook) Kuntze. Dotted Button-snakeroot. Abundant in valley and on open rolling prairie on dry gravelly and stony soil.

Gutierrezia sarothrae (Pursh) Britt and Rusby. Gutierrezia. On gravelly and stony hillsides of prairie.

Grindelia squarrosa (Pursh) Dunal. Broad-leaved Gum plant. Common along cuts and valleys on heavy clay soil.

Chrysopsis villosa (Pursh) Nutt. Hairy Golden Aster. Common on sandy, gravelly and stony soils of Cannon Ball valley and ranging over prairie on hillsides and up to the top of high buttes such as Coffin and Pretty Rock.

Chrysopsis bakeri Greene. Among brush along banks of Cannon Ball river and on sides and tops of stony hills.

Sideranthus spinulosus (Nutt) Sweet. Cut-leaved Sideranthus. Scattered over hillsides of rolling prairie on sandy, gravelly and stony soils. Found on stony top of Coffin butte.

Solidago missouriensis Nutt. Missouri Goldenrod. On stony and gravelly soil of rolling prairie, among low shrubbery on sides of Pretty Rock butte and on stony soil at top of Coffin butte.

Solidago canadensis L. Canada Goldenrod. Along banks of Cannon Ball river and by cuts in valleys and among buttes.

Solidago nemoralis Ait. Gray or Field Goldenrod. On sandy soil in valleys and ranging to stony soil on top of buttes. Occasional among shrubbery.

Solidago mollis Bartl. Velvety Goldenrod. On gravelly and stony soil of open rolling prairie and ranging to top of high hills and buttes.

Solidago rigida L. Stiff or Hard-leaved Goldenrod. On stony soil of rolling prairie and in cuts on hillsides bordering Cannon Ball valley and on sides of buttes.

Aster oblongifolius Nutt. Aromatic Aster. Occasional on sandy soil in valleys. Common on stony banks, bluffs and buttes.

Aster laevis L. Smooth Aster. Along banks of Cannon Ball river and banks of tributary creeks and cuts.

Aster ptarmicoides (Nees) T. & G. Upland White Aster. On dry, stony soil on hillsides.

Aster paniculatus Lam. Tall white or Panicled Aster. Abundant in cuts between buttes at Pretty Rock.

Aster multiflorus Ait. Dense-flowered Aster. In dry, open valleys and along cuts between hills of rolling prairie.

Aster exiguus (Fernald) Rydb. Ciliate-leaved Aster. Abundant on dry, stony hillsides. Found occasionally along banks of Cannon Ball river and in wooded cuts on hillsides bordering the valley.

Aster commutatus Torr and Gray. White Prairie Aster. Abundant on sandy, gravelly and stony soil over rolling prairie and ranging over tops of stony hills and up the sides of buttes.

Aster pauciflorus Nutt. On heavy clay spots in sloughs between stony hills.

Erigeron asper Nutt. Rough Erigeron. Ranging over prairie on gravelly and stony soil.

Erigeron pumilus Nutt. Low Erigeron. On sandy soil among buttes.

Erigeron ramosus (Walt) B. S. P. Daisy Fleabane. Common on sandy soil in low situations. Occasional on stony hillsides.

Leptilon canadense (L) Britton. Horse-weed. Canada Fleabane. On sandy banks of cuts in sides of buttes.

Leptilon divaricatum (Michx.) Raf. Low Horseweed. On sandy and heavy clay soil between stony hills.

Ratibida columnaris (Sims) D. Don. Long-headed or Prairie Cone-flower. Abundant on sandy, gravelly and stony situations throughout the area.

Brauneria angustifolia (D. C.) Heller. Narrow-leaved Purple Cone-flower. Common on stony hillsides and hilltops.

Brauneria pallida (Nutt) Britton. Pale Purple Cone-flower. Abundant on dry, sandy and stony hillsides of open rolling prairie.

Helianthus subrhomboideus Rydb. Rhombic-leaved Sunflower. Abundant over prairie hillsides.

Helianthus maximiliani Schrad. Maximilian's Sunflower. Abundant along banks of dry creeks and cuts.

Helianthus tuberosus L. Jerusalem Artichoke. Occasional along cuts in valleys.

Coreopsis tinctoria Nutt. Garden Tickseed. On heavy, clay soil in bottom of a slough.

Bidens cernua L. Smaller or Nodding Bur-Marigold. Along moist cuts between hills.

Bidens frondosa L. Black Beggar-ticks. Occasional in deep wooded cuts. Often a troublesome weed in fields.

Hymenopappus filifolius Hook. Low Tufted Hymenopappus. On stony hillsides of rolling prairie and on top of high buttes.

Picradeniopsis oppositifolia (Nutt) Rydb. False Bahia. On dry, stony hillsides and buttes. Occasional on heavy clay soil.

Tetraneuris simplex A. Nelson. Simple Tetraneuris. On stony hillsides.

Boebera papposa (Vent) Rydb. Fetid Marigold. False Dog-fennel. In edge of an old barnyard and on heavy clay soil in prairie-dog towns.

Achillea lanulosa Nutt. Western Yarrow. Among woods and on sandy flats by Cannon Ball river.

Artemisia caudata Michx. Tall or Wild Wormwood. Common on dry, sandy prairie and ranging up sides to top of high, stony hills.

Artemisia dracunculoides Pursh. Linear-leaved Wormwood. Common on dry, sandy, gravelly and stony soil.

Artemisia frigida Willd. Pasture Sage-brush. Wormwood Sage. Abundant on gravelly soil on open prairie. A valuable forage plant.

Artemisia biennis Willd. Biennial Wormwood. Along banks of Cannon Ball river.

Artemisia gnaphalodes Nutt. Prairie, Western or Cud-weed, Mug-wort. On stony rolling prairie.

Artemisia ludoviciana Nutt. Lobed Cud-weed. Along banks of dry cuts between buttes.

Artemisia cana Pursh. Hoary Sage-brush. In stony situation on top of Pretty Rock butte.

Senecio integerrimus Nutt. Entire-leaved Groundsel. On sides of high, grassy banks among buttes.

Senecio pursh ianus Nutt. Pursh's Groundsel. Occasional on sides of high, stony hills.

Senecio plattensis Nutt. Prairie Ragwort. On sides and tops of high buttes.

Carduus undulatus Nutt. Wavy-leaved Thistle. Scattered over prairie, hillsides and valleys.

Carduus arvensis (L) Robs. Canada Thistle. By a small cut in Cannon Ball valley. A pernicious weed which should be rigidly exterminated.

SOIL SURVEY OF DAWSON AREA.

KIDDER COUNTY, NORTH DAKOTA.

By Herbert A. Hard and Harold McKinstry.

DESCRIPTION OF THE AREA.

The Dawson area is located in Kidder county, about midway between the north and south county lines, and extends the entire distance across the county from east to west, making an oblong area 12x30 miles, or 360 square miles, which includes townships 139 and 140 from ranges 70 to 74 inclusive.

The area may be divided lnto two distinct topographic divisions. The larger of these divisions includes the portion which is slightly undulating to hilly, while the other portion, which composes the extreme northern and eastern parts of the area, is known as the Gary Moraine, a range of high, rough. stony hills left by the ancient glacier which swept over Canada and extended down into the United States. The rougher portion is marked by an occasional "draw" which often leads to a slough hole, a very typical structure. To add to the roughness, considerable stone and gravel are scattered promiscuously over much of the area. The low places afford excellent drainage and they are usually numerous enough, so that the whole country might be drained into them; but, because of the light texture of the soil and the low water table, drainage is seldom necessary. While the banks of such holes are usually quite steep, the bottoms are almost level, and may be from five or six feet to thirty-five or forty feet below the adjacent country. Since all the surplus surface water drains into these places, they often contain more or less water in the spring of the year; but almost invariably dry up before the summer is very far advanced.

South of Dawson is a group of sloughs and lakes which seldom dry up and afford excellent drainage for the surrounding country, and also hold the water table at a good level. Among the group of lakes is Lake Isabelle, one which is known throughout the country because of its good bathing beach and the comparative freshness of

the water, as most of the lakes in the country are muddy and contain a high per cent of alkali. The greater part of the alkali lakes, however, are north of Dawson, where they cover a great many acres, making the land absolutely useless either for grazing or agriculture; and, because of the strong odor, make the vicinity a very undesirable place in which to live. The alkaline lakes and spots total somewhat less than 5,000 acres, occupying what would otherwise be some of the best loams of the area.

The area is not thickly populated, and most of the people who are there have settled there quite recently and compose the third group of settlers who have tried to establish homes in the community. The present population consists of people of various nationalities, including Americans, Germans, Russians and Scandinavians, the first being very much in the majority. The greater portion of the people who have recently arrived are Americans, many of whom have received an average education.

Most of the cultivated land is found along the railway, although with the last few good seasons, considerable land is being farmed several miles back, especially north and northwest of Steele, where the soil becomes a trifle heavier and not so rapidly dried out. There the farms are kept in better condition and the buildings show signs of more prosperity than found anywhere else on the area, but even there only a comparatively few very good buildings can be found; and in many places the sod huts and tar-papered shacks remain as they were built when the land was homesteaded.

On the sandy soil the county roads are good the year around excepting that, when very dry, the sand cuts and works up. On the heavier soil the roads become slippery and sticky during the spring and rainy weather.

HISTORY AND TOWNS.

Kidder county, in which the Dawson area is located, was organized in October, 1881. Previous to this time the few settlers who had come into the county directed their effort towards ranching; but, as the settlers became more numerous, and grazing land became more scarce, the ranchers either sold their cattle and commenced to raise grain or moved farther west; so that, when the county was organized, very few ranchers remained.

The main line of the Northern Pacific Railway extends across the county from east to west, a distance of thirty miles, along which

North side section 7, township 139, range 73—Hills of Gray Moraine.

North side section 7, township 139, range 73—Typical hills of the Gary moraine, about eight miles north of Steele. They are used only for grazing land.

are located four towns, which can be easily reached from the southern three-quarters of the county, while most of the farmers in the northern portion of the county may easily drive to the town along a spur of the Northern Pacific Railway, which extends west, about ten miles north of the Kidder county line. These give direct communication with the grain markets of Minneapolis and Duluth.

Steele, which is the county seat, was perhaps the first settlement in Kidder county. It has a population of about 550 inhabitants, most of whom are Americans. It contains two banks, several very good stores, elevators, two churches and a good school, all of which are supported by people from all parts of the county, many leaving other towns to do their trading there. Very few of the pioneers have remained there. It was founded by Col. W. F. Steele of Rippon, Wis., the first settler, who reached there in 1877. A few who have done a great deal toward making the town what it is should be mentioned. One of the first lawyers to practice there was Joseph W. Walker, who arrived March, 1883, and who still resides there. He now holds the office of state's attorney. Chas. H. Stanley and E. N. Parker arrived there the following month. The latter is now one of the justices of the supreme court in the state of Washington. Dr. John Harcourt, now dead, who reached Steele in 1882, was the first to practice medicine. The following year a bank was opened by A. G. Clark, M. C. Doodsell, W. L. Belldon, now Indian agent on the Standing Rock reservation; Fred C. Barkman and J. A. Fay opened stores of various kinds.

The little town of Dawson, which lies eight miles east of Steele, was founded by J. Dawson Thompson, who is now a millionaire in California. He came to Dawson in 1880 and laid out the town in 1882. Raymond & Keppler started a general store there in 1882 and are still there, as is also F. W. Benjamin, blacksmith.

Tappen, which lies five miles east of Dawson, has about sixty inhabitants and was originally the headquarters of the 10,200-acre Troy farm, which was at that time owned by John Van Deuzen of Troy, N. Y.

Crystal Springs is located only about a mile and a half from the east county line and contains a postoffice and one store. There are several small lakes close by, kept fresh the year round by beautiful springs, which are quite numerous in that locality and give name to the town.

CLIMATE.

The climate of the Dawson area is typical of the Northwest, possessing long cold winters and short cool summers, although there are always a few of the summer days which are very warm. The nights, however, are usually cool and the days are long, making conditions almost ideal for a growing season. The last killing frost in the spring comes about May 15, and the first in the fall at about September 20, although lighter frosts may occur between these dates and may possibly occur every month. The hot south winds so common during the summer season are often harmful to crops; and the repeated freezing and thawing which occurs in the spring results in the killing of trees, shrubs, grasses, and winter wheat or rye. In the protected valleys where the snow lies deep in the winter and the wind does not strike in the summer, neither of these objections is very noticeable; but the high or level ground suffers.

The windbreaks scattered over the area are extremely scarce in spite of the fact that many groves have been started. Only where cultivation was continued after the young trees were set have they amounted to anything, as they soon become sod-bound if left to themselves, and in some cases the canker worms have killed the trees after they had grown to a fairly large size.

The following data was obtained at Bismarck, the Weather Bureau nearest the area, through the kindness of Mr. O. W. Roberts, section director.

Normal monthly and annual temperature and precipitation for the last 34 years:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature in Degrees	7.0	9.6	22.7	42.9	54.3	63.4	69.3	67.6	57.7	44.7	27.3	15.4	40.0
Precipitation in Inches	0.43	0.53	1.06	1.76	2.43	3.35	2.19	1.95	1.17	1.04	0.67	0.59	17.50

A complete record of the precipitation was also obtained for Steele, covering the last 14 years.

Precipitation in Inches	0.34	0.49	0.93	1.17	2.22	3.38	2.63	2.17	1.17	0.74	0.66	0.32	16.22

An average annual precipitation of 16-17 inches on a soil supported by a sandy subsoil, such as this area has, naturally requires the constant use of a dust mulch and all other means of water conservation.

Flowing Well—seven miles north of Steele, which furnishes a half inch flow throughout the year. The water is very clear and cold, but contains a little alkali. Well is 20 feet deep and water was struck just above the hardpan. After reaching a depth of 20 feet the workman left his pick and shovel in the well, and went to dinner. Upon his return the hole was full of water, and has been flowing steadily ever since.—N. W. Cor. Sec. 13, T. 140, R. 73.

Flowing Well—northeast corner southeast quarter, section 15, township 139, range 74—History of well could not be obtained, but the well is all that remains to mark the location of a deserted farm.

The following frost data for the last 17 years for Jamestown in the county next east shows approximately the conditions in Kidder county:

Average date of first killing frost in autumn, September 15.

Average date of last killing frost in spring, May 30.

Earliest date of killing frost in autumn, August 20.

Latest date of killing frost in spring, June 28.

The following interesting data for Burleigh county, just west, shows in detail the variation in date of the first killing frost since 1874:

1875, September 19	1893, September 16.
1876, September 20.	1894, September 17.
1877, September 20.	1895, August 31.
1878, September 10.	1896, September 10.
1879, September 18.	1897, September 16.
1880, September 13.	1898, September 9.
1881, September 15.	1899, September 19.
1882, September 23.	1900, September 26.
1883, September 8.	1901, September 18.
1884, September 27.	1902, September 12.
1885, October 3.	1903, September 14.
1886, September 18.	1904, September 11.
1887, September 15.	1905, October 11.
1888, September 12.	1906, October 9.
1889, September 26.	1907, September 27.
1890, September 26.	1908, September 27.
1891, August 23.	1909, September 24.
1892, September 13.	1910, September 9.

The average date for arrival of frost here is September 18, and only on three occasions, 1883, 1891 and 1895, has it arrived earlier than it did in 1910. Eighteen years ago there was frost on the same date and four years ago it held off for one month longer than it did this year. The latest date of killing frost in spring in the last thirty-four years is June 7, while the average is May 11.

The Dakota winter is very cold, as recorded by the thermometer. However, the air is dry, and the cold is not felt in proportion to the degree. In fact, if one dresses warmly, he does not suffer as he does from the insidious and penetrating chill of the moister east-

ern climate of higher temperature. The result is an invigorating, healthful climate.

There is not sufficient rainfall to produce the best of crops on the sandy soil; but, with the average rainfall, the yields are good on the heavy land and fair on the sand.

AGRICULTURE.

About the year 1880 the first settlers filed on and commenced to cultivate the land in the Dawson area. It was taken up and broken slowly at first, as has been the case ever since; and there is still a large part of it in the virgin state. Most of this is held by large eastern land companies for speculation, and can not be purchased except for unreasonably high prices, from $15 to $35 per acre. The raising of small grains—wheat, oats, barley, rye and flax—is attempted year after year; but only small yields are secured. Potatoes are raised only in small quantities, although they yield from 100 bushels in the sandy soil to 300 bushels per acre under the most favorable conditions in the heavier soil. Corn is raised for feed by those who practice diversified farming, and it is a fairly reliable crop, but not extensively grown. Neither is cattle raising practiced to any great extent, although nearly every farmer who is at all prosperous makes cattle raising and dairying no small part of his farm work. Truck raising is profitable on both the heavy and light soils, but it is seldom practiced to any marked extent except for home consumption. There is a marked tendency on the part of the farmer to raise grain only and neglect the application of manure. Returns will not be large or certain until a system of diversified farming is adopted accompanied by careful use of fertilizer.

The majority of farms contain only about 160 acres, of which only a small acreage is usually cultivated. It is often the case, however, that the land companies which hold large tracts break up several sections of this land, to which flax is seeded. In good seasons this crop yields from nine bushels to eighteen bushels per acre on new land, but the same yield is seldom secured two years in succession.

It is very evident that no very great degree of prosperity will be reached by any of the farmers until they keep more live stock. Those who have steadily made a practice of this are the only ones who can boast of any prosperity whatever. Only occasionally are well

One of the richest appearing farmsteads on the area. The barns are quite old and much in need of paint, but the house is new.—Southeast corner section 10, township 139, range 74.

painted farm buildings found over the greater part of the area; but north and northwest of Steele are some fairly good farmsteads.

Most of the plowing is done by gangplows drawn by four horses, but the breaking of sod is usually done by means of gasoline traction engines which turn six or eight furrows at a time. Plowing usually begins as soon as the grain is cut on the better soil, but in the poorer districts it is often delayed till the spring, as the rank growth of Russian thistle, which infests all the sandy land, is capable of holding more snow than the plowed fields. No sooner is the soil turned over than it pulverizes to such an extent that a comparatively smooth field is left, with nothing whatever to hold the snow. While much of the land lies idle year after year, there is very little summerfallowing practiced. It produces an enormous crop of thistles and weeds of various kinds which are allowed to go to seed and infest the good land as well as the poor. These thistles, however, do not grow to any extent on the heavy soil, but only on that which is very sandy. When the land does become infested with the pest, very little effort is made to kill it out; and the land is often deserted.

Conditions are almost ideal for stock raising, as the large tracts of unused land affrod an unlimited supply of hay and excellent pasturage. Much of the land is covered with Buffalo grass; but, on the more sandy portions, there is a great deal of less nutritious grass mixed in. Because of the dry seasons this grass is seldom cut more than once every two years; but it can then be easily cured, and makes fine hay. Cattle readily fatten on the pasture with no grain whatever, and are shipped to St. Paul, where they are sold as fattened stock. A few sheep are raised; but, because of the high rent which eastern land owners charge for pasturage, this industry is not large. Very few hogs are raised for market, but all the better farmers raise enough for their own pork.

Most of the labor is done on the farms by the owners and their families, so there is very little opportunity for outsiders to obtain work even in the harvest or hay field.

The water supply for drinking purposes has three sources, namely, surface wells or those dug by hand, artesian wells, and springs, all of which furnish fairly good water. The artesian wells are bored all the way from twenty feet to 500 feet deep, but are very scarce. The surface wells range from six to ninety feet in depth. Strong veins are often struck which are inexhaustible and supply excellent

water the year around, but are commonly known as surface wells because of their slight depth.

One has but to ride a short time in this district to have brought to his attention a large source of loss in the exposure of farm implements. Very few farmers make any pretense at all of sheltering machinery and vehicles. One of the most melancholy sights that greet the eye is the frequent farmstead with the buildings surrounded on all sides by a profusion of machinery in all stages of destruction, from last season's fine drill, header and other tools with its bright new coat of paint, blistered and weather beaten on the exposed side, on down to that "generation" of implements of few years' use but many layers of rust, disabled before its time.

At one farm near Tappen three new grain drills with all attachments complete, as many manure spreaders and other machinery in proportion were seen late in the summer, long after the owner had ceased to use them, standing out in the elements deteriorating as rapidly as possible. It only completes the story to say that some of these chattels had changed owners twice and were about to pass from the present unsuccessful one.

Shed room could be constructed cheaply even here, where railroad rates on lumber are high, when sod walls will stand for many years, and boards bent to moderate arch will suffice with gentle pitch to shed the scant rainfall and protect from wind and rain. Many of the houses and most of what few outbuildings there are are weather-beaten for lack of preserving paint. True, lack of ready money accounts for much of this, but as often it is lack of concern. It is interesting to observe that, when a frame barn is aspired to, it is often the most imposing structure on the farm. However, many of the better class of farmers have things better proportioned.

Some good "tree-claims" are seen on the area. However, here, as in most new countries, the settler "has not time" to plant sufficient wind-breaks and shade shelters. The government has been generous in remission of taxes for willingness to plant and care for trees. Some advantage was at first taken of this. Cottonwood and box-elder were planted by a few men. These were cared for but a short time by many farmers and, since the tree requires constant cultivation to conserve the moisture and prevent it becoming sod bound, they soon began to die in the less favored spots. Many groves have almost disappeared for want of care, but those which were well

treated mark the most refreshing spots and beautify otherwise humble prairie homes.

Some of the most effective windbreaks along the N. P. R. R. are trees, and a large outlay has been made on them. Unfortunately section men are not ordered to burn around these in the dry sason and often wild fires girdle them.

The unfortunate tendency of many farmers to consider this area of the same character as the fertile Red River valley, and as such to be capable of giving large yields with little investment and work, is painfully apparent. Shallow plowing is the rule and the dust mulch is little known. On the other hand the soil should be plowed as deep as moisture makes it practicable when broken the first time and this repeated every second fall at least. Intermediate plowings might be as shallow as the deepest of present work done by the more careful farmers.

Where fall plowing is possible it will go a long way towards breaking up grasshopper nests ,destroying the eggs, and abating that pest, while summer plowing, just after the crop is removed, prevents the growth of weeds which would otherwise sap the ground moisture. The frequent cultivation necessary to the growing of corn is another fine means of getting rid of weeds; giving another big reason for including that crop in rotation.

Thousands of acres are seen each summer which have been plowed to a depth of three inches. On this, with no preparation of seed bed whatever, the grain is sown, one-third to nine-tenths of which either never sprouts or, if it does, soon dies in a dry climate where the moisture has not been conserved. The furrow slice, not being worked down to a compact bed, often never has capillary connection established with the subsoil, and, perhaps resting on the inverted grass or weeds, dries out to a degree fatal to germinating seeds. Literally, miles of wheat, oats and flax suffered this fate the past season. In short the underground water will be brought up to the plants if a firm seed bed is prepared by pulverizing the soil and firming it down in contact with the subsoil. That the water may not continue its journey out to the surface and be lost by evaporation, a surface mulch must be prepared. Further, the firming of the ground by the use of a sub-surface packer will tend to give a layer sufficiently compact to prevent the drill shoe or disk running more than about two inches and placing the seed so deep as to cause its vitality to be destroyed before its sprout reaches the surface. In sec-

tion after section of Kidder county land planted to flax this year, those grains which the drill chanced to drop between the bald upturned and undisturbed furrow-slices, by rare good luck got deep enough to take root, while those less favored grains, embedded within the slice were never able to get moisture nough to force the root down below the surface litter which had been covered. As a result the ground was covered with dead stalks of immature plants. Other stalks becoming yellow were preparing to join them, until the crop was a total failure.

During the recent drouth poor seed bed increased the losses caused by use of poor and disease-infested seed by giving poor sustenance to a weak plant. Where disease is known to exist the seed should be disinfected before planting.

Deep fall plowing, good seed and seed bed, and the preparation of a dust mulch, which in these light soils is quite easily made after each rain, would insure a good yield in an average season on the newer land. But these lands as well as all others wear out in time if the fertility is not restored. It is estimated that one-third of the phosphorus, one of the most important foods of the soil, is removed by crops in about half a century and that four million dollars worth are removed annually from our state. When we consider the fact that our yield of wheat in 1899, a good year, was but thirteen bushels per acre it is high time that our farmers cease to burn annually seven or eight millions of dollars worth of straw, much of whose value lies in its relation to fertilization. It is time to cease to burn or let lie in disuse great piles of manure which stand like small mountains in many barn lots.

As an average of the last sixteen years the Ohio experiment station has produced eleven bushels of wheat per acre in a five-year rotation of corn, oats, wheat, clover and timothy, where wheat is grown on the same land but once in five years. But where eight tons per acre of farm manure have been applied twice during each five-year period the average yield of wheat has been twenty-one bushels per acre, and where commercial plant food has been applied without any farm manure the average yield has been twenty-seven and one-half bushels per acre.

At the Rothamsted experiment station in England, where barley has been grown on the same land every year for more than half a century the average yield for fifty-five years where commercial plant food has been applied is forty-three and two-tenths bushels, but

where barley has been grown in a four-year rotation with clover, wheat and turnips, the average yield of barley where no manure or fertilizers have been used was forty-five bushels in 1848, thirty-eight bushels as an average of the first twenty years, twenty-two and one-half bushels as an average of the next twenty years and less than fourteen bushels per acre as an average of the last twenty years.

"When we learn how and when to cultivate the soil, when we have developed cereals thoroughly adapted to our soil and climatic conditions, when we have adopted rotations that will properly areate soil, destroy moisture and fertility absorbing weeds, and rid the soil of fungus diseases that otherwise bid fair to destroy the chief industry of this state, then we may conclude that agriculture is coming into its own. Until then we must preach and write and urge and educate. The next generation of farmers should be highly and specially educated for their vocation."—*Pres. Worst.*

SOILS.

While the soil of the Dawson area is all of glacial origin, it has been under the influence of the weather for so many years that now the low places contain the wash from the higher ground, which is often comparatively heavy and consequently more productive than the soil of the present higher land. About the only heavy soil found outside of these depressions is that in the morainic hills along the northern side of the area, and there it is usually found in such small spots that it can not be mapped.

But four distinct types of soil were found in the area, the acreage of each being shown in the following:

Coarse sand, 330 acres.

Medium sand, 103,040 acres.

Fine sandy loam, 115,200 acres.

Clay, 8,320 acres.

Peat, 150 acres.

Slough, 3,360 acres.

The above shows how extremely light the soil of the region is. Coupled with a subsoil light to a great depth, and in a region of low precipitation, it is little wonder that the crops are light.

COARSE SAND.

The gravel, which has already been mentioned in connection with some of the other types, is found only in small areas, but there are

two areas large enough to be mapped. One is west of Steele and the other is at Ladoga. It is stratafied all the way down and is very uniform; but has no agricultural value and is only used for grading or filling, mostly on the railway, as it contains too much fine material to be of any use for concrete work. After about 80 per cent of gravel and other coarse material was removed, the mechanical analysis of the remainder was as follows:

	Hygroscopic Moisture	Fine Gravel	Coarse Sand	Medi'm Sand	Fine Sand	Very Fine Sand	Silt	Clay
Soil	2.55	12.81	12.48	7.59	22.96	23.28	15.07	3.17
Subsoil	2.79	42.63	10.90	3.33	38.50	3.42	1.02	0.08

The subsoil is fine gravel.

MEDIUM SAND, PHASE A.

The sand covers next to the largest area of any one type and is of less value than any other. In phase a, from eight inches to fourteen inches down there may be found enough organic matter to give a black or dark brown color, and often enough to produce a loamy character. The quantity of organic matter may vary greatly within a very short distance, or it may remain quite uniform for several miles at a stretch. The subsoil is quite uniform, regardless of the soil, with one exception. Large stones and gravel are scattered promiscuously over the entire area; small spots only a few feet in diameter may be found where stone and gravel are very thick while a few feet away there may be nothing but uniform sand with either a high or low percentage of organic matter. In many cases the stones are so thick that dynamite is almost necessary to dig even a small excavation, but such spots are so small and scattered that they could not be shown on the map. The soil color was found to vary from a light gray to a reddish brown. The latter color was seldom found, and never on the surface, but at a depth of from one to three feet. The grains in the darker sand were a tifle sharper and more irregular in shape; but the texture was very similar, and the soil was identical with that where the gray sand was found. Often at a depth of from twelve to thirty-six inches a thin stratum of finer sand was found, which was usually light gray in color, although occasionally a trifle darker. This stratum was always very shallow and was found only in small spots, usually in the lower ground or where there had been a chance for some wash.

The topography ranged from gently rolling to hilly, but was not at all rugged. In many places, notably at Dawson, where the sod has been broken and left bare to the wind, the soil is now drifted and is still drifting into small dunes from five feet to twenty feet in height, which soon become covered with grass, thereby checking the action of the wind upon them to any appreciable extent. Because of the coarse texture of the sand, very little erosion is carried on by water, since the water soaks in as fast as it falls and has no chance to wash out gullies, except on the very steep slopes, which are scarce. The lower areas around these knolls or dunes are very much richer in organic matter than higher up, and produce fairly good yields of wild hay.

The soil will never be valuable for the growing of cereals, but it can be made to produce fair yields of stock food (roughage) of various kinds. Corn will usually mature before the first killing frost, and produces about thirty bushels per acre. Potatoes yield from seventy-five bushels to 150 bushels per acre. From two to four tons of tame grass such as brome, timothy and red top are realized. There is no apparent reason why alfalfa should not do well on much of the lower ground after a stand is once obtained; but, because of the dry weather, considerable difficulty would probably be had in getting it started. Roots of most any kind do well; and, as the growing season is comparatively long, hogs can be kept on this and other green pasture a good share of the year and large profits realized from them.

Mechanical Analysis of Carrington Fine Sandy Loam (a)

	Hygroscopic Moisture	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Silt	Clay
Soil	0.95	4.60	8.335	26.00	33.70	10.59	2.67	1.52
Subsoil	0.65	3.11	16.19	31.38	35.79	8.68	1.80	2.09

MEDIUM SAND, PHASE B.

This phase, which verges closely upon the first in texture, is probably next in agricultural value as well. It does not occupy very much territory; but is usually found bordering upon the first phase; and blends so gradually into it that considerable difficulty was found in accurately establishing a boundary line unless, as was occasionally the case, the second was found to occupy the bottom of a depression surrounded by another type. It is heavier than a.

The upper ten to fourteen inches is usually a black sand varying in texture up to a very light sandy loam. More or less gravel and large stones are found over nearly the entire phase; but, as a rule, they are grouped in spots too small to be mapped.

The subsoil is lighter in color, and the texture is often the same as that of a. There is a marked tendency, however, for it to be heavier in places, containing much silt and clay as in the analysis appended. This is often found as a thin stratum just below the soil, varying in depth from one to six inches or even eight inches near some old lake bed or an alkali lake. That which is found near the alkali lakes has a peculiarity of its own, which can seldom be seen on any other part of the area. It is simply a sandy clay so composed that when wet it is quite tenacious and may pack almost like pure clay where there is much travel; but no sooner is it dry than it crumbles, and closely resembles pure sand except upon close observation. Mechanical analysis indicated a fine sandy loam in much of the phase.

The topography ranges from hilly to rough and hilly, but there are a few places which are but little more than rolling.

There is some tendency for this soil to erode rather badly by means of water but not by wind except where the bare ground is exposed to the weather long enough to become thoroughly dried out and then only to a slight extent, as the organic matter holds it in place. On hillsides, where roads extend down the slopes, the finer material becomes washed out and only coarse sand and gravel remain. However, the track usually becomes quite deep before the coarse material appears in any great quantity, unless it is on a very gravelly or stony knoll.

Because of the light subsoil, the soil is of very little more value for farming than *a;* and it is not quite so easily kept mulched where rains are frequent. The increase in yield of this soil over that of *a* is very little.

Mechanical Analysis of Carrington Fine Sandy Loam (b)

	Hygroscopic Moisture	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Silt	Clay
Soil	2.975	4.84	8.33	14 67	36.98	20.70	7.25	4.83
Subsoil	1.465	3.86	6.47	9.79	14.96	18.02	19.17	27.43

FINE SANDY LOAM. PHASE A.

Fine sandy loam, phase a, which is found in large quantities at both the eastern and western end of the area, covers a larger sized territory than any other type, and is quite a deal more valuable in nearly every respect than the sand. It is found in all kinds of topography and, while not very uniform, it remains constant enough to be classified the same for miles at a stretch. It varies from a very heavy fine sandy loam verging closely upon a loam to a very light fine sandy loam verging closely upon a sand. The upper nine to twelve inches consists of a dark brown or black fine sandy loam, often so soft that when wet it feels very much like a silt loam. More or less coarser material is often found in it, and occasionally in sufficiently large quantities to make it a sandy loam; but such spots are only a few rods in diameter, and cannot be indicated on the map. The soil usually becomes heavier until a depth of eighteen to thirty inches is reached, when a medium sand is encountered, which extends many feet down, although it may be clearly varied by strata of blue or yellow sandy clay. The highest percentage of clay is found at a depth of from twenty to thirty-four inches. There may be a sharp boundary line between this clay and the underlying sand, or there may be a gradual blending through from six to fifteen inches of earth, although the change is usually quite clearly marked. This area might have been classed as sand but for the character of the subsoil, a pronounced fine sandy loam.

The subsoil becomes quite tenacious when wet, but dries out easily and then becomes as loose and granular as sand, although it may sometimes contain enough clay so that when packed it forms a layer so hard and dry that plant roots can not penetrate it.

Stones are scattered over most of the area, although a portion of it lying north of Steele is comparatively free from them. Steele is located on the south edge of a low level area of fine sandy loam in which scarcely a stone can be found. Small gravelly knolls are also found which range in diameter from six to fifty feet. They may be gravelly only on the surface or to a great depth, as is quite often the case. The grain on such knolls is usually very much thinner than on the lower ground, and many farmers plow around them; or, where they are very numerous, the land is only used for pasture.

From eight to fifteen bushels of flax may be realized from this type the first or second year after breaking; and fairly good crops

of oats, wheat and barley may be raised on the old land during wet years. Winter rye is a common crop, as it usually matures before the soil becomes very dry in the late summer. It yields from ten to twenty bushels per acre, but, because of the low feeding value of the straw many farmers hesitate to grow it. Potatoes yield from 100 to 250 bushels per acre but are not at all a certain crop because of the liability of drouth.

Mechanical Analysis of Carrington Fine Sandy Loam (a)

	Hygroscopic Moisture	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Silt	Clay
Soil	4.125	10.52	4.73	6.18	18.50	36.45	12.93	6.10
Subsoil	3.67	8.60	3.08	4.08	8.36	35.29	16.75	22.22

FINE SANDY LOAM. PHASE B.

This phase covers a smaller territory than does fine sandy loam *a*, but it ranks second in agricultural value. It is found in comparatively small spots; and only along the northern side of the area, especially north of Steele, are there any spots of valuable size. It is usually found in the lower land or on the highest of the morainic hills—that found in the latter place being the most typical of the type.

The soil to a depth of ten to fourteen inches is a very dark brown or black (usually the latter) soft, fine sandy loam, which is remarkably uniform except in the lower areas, where it often contains more sand and organic matter, verging closely upon a sand.

The subsoil, to a depth of twenty-six to forty inches gradually becomes heavier and is a loam, but then changes to a sandy clay or medium sand. Several feet farther down a clay is sometimes found which extends to almost an unlimited depth, but it is usually quite dry and hard, thereby making the penetration of plant roots into it very difficult. Small grains have been very successfully raised on the soil. During a good season wheat yields from fifteen to twenty-five bushels per acre, oats twenty to forty bushels and barley eighteen to thirty-five bushels per acre. Potatoes are also successfully grown and produce from 200 to 300 bushels per acre.

Mechanical Analysis of Carrington Fine Sandy Loam (b)

	Hygroscopic Moisture	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Silt	Clay
Soil	7.225	8.60	2.76	1.90	9.44	25.30	28.48	16.49
Subsoil	3.965	1.00	2.46	1.94	7.36	26.26	31.54	26.48

CLAY, PHASE A.

Clay is found only in low, poorly drained areas, either old filled-in pond or creek beds. The soil ranges from nine to twelve inches in depth and is usually of a deep black color, although it may occasionally be tinted with a dark gray or yellow.

The subsoil usually consists of a blue clay which extends to a great depth, often being found by well diggers for forty or fifty feet below the surface, with no sign of any other material. On the other hand it may extend only four or five feet, and is then underlain by a sandy clay or almost a pure sand.

The soil is extremely heavy and becomes very hard and difficult to cultivate unless worked at the proper time; but, when properly worked, it produces excellent crops, and is by far the most productive soil in the area. It is especially adapted to wheat, oats, barley and flax. While corn does well on it, there is more danger of the crop being killed by frost before it reaches maturity. Wheat yields from fifteen to thirty bushels or even thirty-five bushels per acre; oats from thirty to fifty-five bushels and flax from eight to eighteen bushels. Potatoes, however, require a lighter soil.

Mechanical Analysis of Fargo Clay (a)

	Hygroscopic Moisture	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Silt	Clay
Soil	5.00	0.68	1.81	1.70	6.24	14.97	33.96	35.99
Subsoil	6.075	1.03	0.88	1.13	3.15	8.00	30.50	36.49

CLAY, PHASE B.

This phase occupies only a few of the small undrained depressions, especially in the northern part of the area, near the moraine. The soil consists of a heavy, black clay, rich in organic matter, to a depth of about twelve inches; and is underlain by a clay still heavier but lighter in color. Lime concentrates are frequently found, making small white or gray spots. When this soil becomes dry it cracks up in large chunks from three to eight feet in diameter. The cracks may often be wide enough to allow a buggy wheel to drop in half way to the hub. The clay is locally known as "gumbo" and is seldom cultivated, but used for pasture, or deserted entirely. It is only by very careful cultivation that it can be worked, even in the best seasons.

When wet it is very gummy and rolls upon wagon wheels in large quantities.

Mechanical Analysis of Fargo Clay (b)

	Hygroscopic Moisture	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Silt	Clay
Soil	4.10	0.36	1.49	0.61	3.39	14.99	34.08	37.765
Subsoil	5.485	0.28	1.00	5.70	2.53	13.36	35.2	37.34

DEPTH OF WATER TABLE.

Under each soil type it is seen that the subsoil is entirely too light and sandy, clay usually occurring at quite too great depth to hold the water table up at a level available for vegetation. Even when clay was thus found it was usually either in too thin stratum or of too high sand content to be effective in holding up the water table.

The following shows the result of boring through the subsoil of each soil type until clay was encountered at some depth.

Clay was found in the morainic hills from two to seven feet below the surface. In some of the more sandy places it was not found closer than ten to twelve feet from the surface.

In lake beds it was found from two and one-half to five feet below the surface. The clay was found closer to the surface where the soil was heavier.

Clay was found under phase *b*, fine sandy loam at about five feet, but there was a two-foot layer of very sandy clay just above it. Below the phase *a* it was usually found at about the same depth, but in some places there was sand for more than nine feet. In this as in most other types, the clay content soon becomes very low as one goes down and many feet of sand are found.

PEAT.

The formation known as peat of which there is only about 150 acres, lies in one area in the center of a large meadow just northwest of Tappen. The surface, to a depth of about ten inches, is composed of peat and muck, containing little other material than partially decomposed organic matter. The subsoil is very rich in organic matter and may be described as a mucky loam, which is underlain at a depth of from three to four feet by a sandy clay. Because of the poor drainage of this soil, it has never been cultivated; but large yields of native grass are cut from it every year, unless

the rains are so heavy as to make it too wet to drive over with a team. Large holes have been burned in it in a few places; but such fires only occur during very dry seasons.

SUMMARY.

The Dawson area occupies one-fourth of Kidder county, which is located in the central part of North Dakota. On account of the meager rainfall, the drainage system is very immature. Practically no streams run out into adjoining counties, the precipitation sinking into the ground or evaporating. There are, however, a large number of small undrained lakes, many of which are strongly alkaline and entirely dry up in late summer.

Although the rainfall is small, so large a proportion of it comes in the growing season that, with careful conservation, it is usually ample for growth of fair crops. It is only with the application of the principles of dry farming that any large extent of the area will ever become a great success as an agricultural district.

It spite of the wide annual range of temperature and severe winters, the climate is healthful.

The farms of the area are chiefly operated by the owners, only a small percentage being leased on a share basis, usually of one-half the crop. Wheat, oats, barley, flax and especially hay are the crops principally raised. Land ranges in value from $10 to $30 per acre or even $35, with the best location for market and with the best soil type. The amount of grazing in the whole county is not nearly up to its capacity, and this industry could with great profit be increased several hundred per cent, as the rich native grass is excellent for fattening stock and furnishes an abundant supply of hay.

The Dawson area is divided into just two topographic divisions, but it represents fairly well the topography and soil of the entire county. Four types of soil appear in the area, derived from glacial drift. In some limited areas these have been worked over on small lake floors.

The soil ranges from a light sand to a heavy clay, the heavy material usually being found in the low lying areas.

The sand and fine sandy loam are not of very great value for the raising of small grains, but corn and truck can be successfully grown and these lands make excellent pasturage.

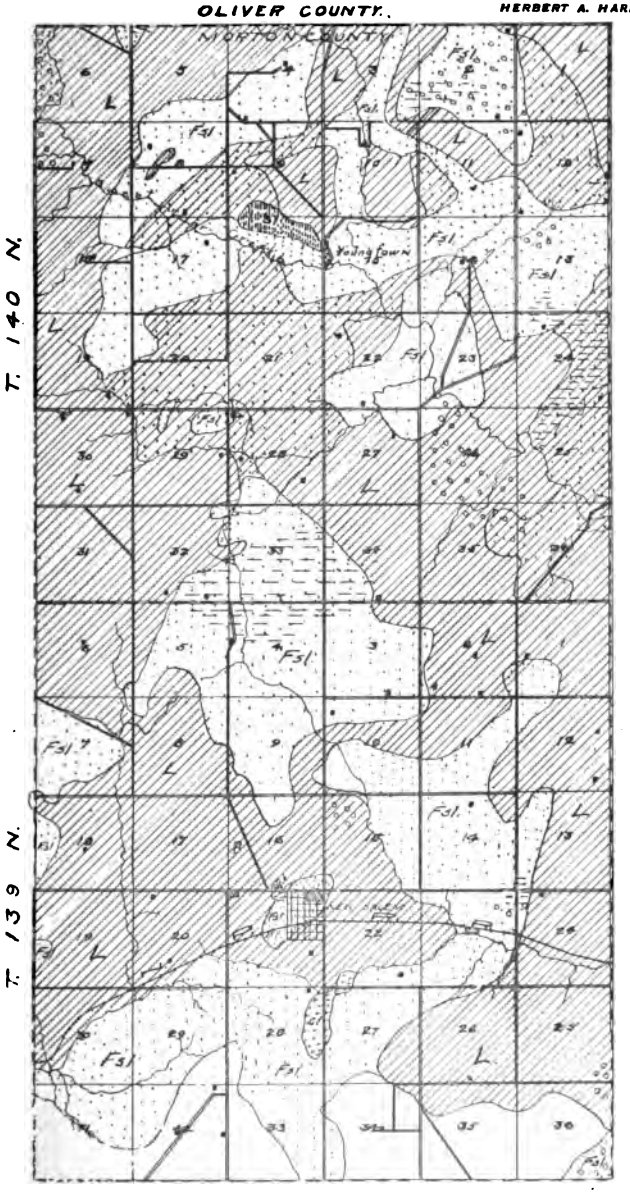
Phase *a* of the clay is especially good for small grains, but is found in such small and poorly drained areas that it can not usually be profitably cultivated.

Much of the soil, although light and very short-lived unless carefully fertilized, produces excellent yields while new, often much better than on many heavier soils; but such yields are only secured for one or two seasons with the most favorable conditions, and from that time on they steadily and rapidly decrease. The best soil is found in the moraines, but it is so hilly and stony that cultivation is nearly impossible. Several deep borings were taken in these hills; and clay was occasionally struck near the surface, although sometimes it was not found nearer than six or seven feet. In a few of the larger depressions, where grain has been raised, the land was found to be very durable, and excellent yields were produced year after year.

Dairying or diversified farming have been very successful wherever practiced; and that appears now to be the only prosperous road open to the farmer who expects to improve his farm. The attempts of the three successive "crops" of settlers—who have come to this region only to move out—to make this part of the state a "bonanza" wheat-producing country have proved futile. Here, to an even more marked degree than in richer, better-watered soils, is it disastrous to attempt to force the soil to yield year after year a bumper small grain crop without fallowing, fertilizing, or rotating crops. These principles along with dry farming tactics will go a long way toward hastening the day when Kidder county will support 50,000 population.

SOIL MAP
NEW SALEM AREA
Morton County, North Dakota.

AGRICULTURAL AND ECONOMIC
GEOLOGICAL SURVEY OF NORTH DAKOTA
HERBERT A. HARD, DIRECTOR.



SOILS SURVEYED
by
HERBERT A. HARD
H.C. McKINSTRY
EDWARD CLARK.
1910.

SOIL OF NEW SALEM AREA.

By Herbert A. Hard and Harold McKinstry.

AGRICULTURAL AND GEOLOGICAL SURVEY OF NORTH DAKOTA.

New Salem is located near the northern boundary of Morton county, about midway between the east and west lines. As the work on that area was just started this year, only two townships were surveyed—139 and 140, range 85.

HISTORY.

The New Salem settlement was started in 1881 by Fred Wiegmann, a merchant, who commenced business at that time in a little two-room shack. Later, that same year, Luck & Knowl opened an implement house and commenced selling the first machinery to the farmers in that country, although a few had been taken there by the first ranchers and farmers from farther east. On April 6, 1883, the German Evangelical Colonization Geselschaft of Chicago, an organization of preachers, established thirty families about New Salem. Since that time the town has been greatly built up, entirely by Germans, and now is one of the most progressive in that part of the country.

When the first farmers went into the country, they practiced only grain raising, and, as crops were not of the best, they were not very successful. It was only a short time, however, before cattle were secured, especially for dairy purposes. The Holsteins were shipped in by a few and have steadily become more numerous, until now they are quite common on nearly every farm, and are furnishing an occupation for the farmers on which the building up of the country has been founded.

TOPOGRAPHY.

While three topographic conditions exist, only two are shown on the map, namely, the gently rolling to hilly and hilly to broken, but broken lands were formed along the creeks only. As such areas are very small and occupied but few acres, they were not indicated on the maps. Most of this broken land was found along the main chan-

nel of the Sweetbriar creek, but occasionally a little was found along the tributaries. Sweetbriar creek, which is fed by numerous springs, drains much of the area, although several brooks flow to the south in the wet season. This could be used to irrigate limited tracts, just as is Apple creek in Burleigh county.

The hills were found in groups, and frequently took the form of a range. They were not of the same origin as those of the Dawson area but were formed by erosion, the tops being protected by thick layers of hard calcareous shale, limestone and burned clay. On a few of the more rugged hills fragments of "scoria" were found. This formation, which is very abundant in the western part of the state, was formed by masses of lignite burning between layers of clay, producing a clinker which was often made porus by the expansion of the moisture in the clay. Often the pores are as large as those of "vessicular scoria" of volcanic origin. In some parts of the area large granite boulders were found scattered promiscuously over the land, while on other parts scarcely one could be found.

A few low undrained "pot holes" exist, but they are very scarce. Such places usually contain clay loam or else "gumbo," which is considered by many farmers practically useless as agricultural land. Such pieces are the last to dry out in the spring; and in the summer they bake very hard in the sun, causing the grain to turn yellow. Drainage on such places is frequently poor, and a large percentage of alkali is not uncommon.

CLIMATE.

The climate of the New Salem area is very similar to that of the Dawson area or possibly a little more mild. The growing season is almost identical, but the snow is apt to thaw more during the winter months. The frosts come at about the same time and the same trouble is experienced in the winter-killing of shrubs and biennials of all kinds by the repeated freezing and thawing.

AGRICULTURE.

Most of the land is being used either for diversified farming or for permanent pasture. Horses are raised by a few of the farmers, but so few are needed on the dairy farms that it is more common to buy them, often having them shippped in from some distance.

Holstein Friesian.
The above is a picture taken of some of the Holstein Friesian cattle owned by John Christiansen, of New Salem.

Hogs are not commonly raised and many farms have none, all the skimmed milk being used for the raising of calves. Nearly every farmer owns a herd of cows, making dairying the leading part of the farm work. This has proven to be a very profitable industry. As a result of this, most of the buildings are very good and the farms in general have an unusually prosperous appearance.

Nearly all the people are Germans and as a rule hard workers, making the most of their time and opportunities for making money and improving their farms. Small groves around the houses are not uncommon but they are usually too small to be of any great value as windbreaks. Drainage is seldom needed, as the soil and subsoil are both so light that the water readily soaks into the ground. Since the water table is low, there is never any danger of the ground becoming too wet.

The pioneers of the New Salem area commenced their work about the year 1881. Very few of them possessed any cattle at the time, but made a living by raising grain and truck, usually grinding their own flour. Although much of the soil is still in the virgin state and will probably remain so for some time, it is steadily becoming more valuable because of the diversified methods being followed by nearly all the farmers on any land which is cultivated. It will in the course of time probably all be under a high state of cultivation.

Very little of the land is now held by eastern land companies, as the farmers have purchased large holdings from them at high prices, in many cases more than it was worth. In spite of this fact many of the farmers who paid those high prices are now among the most prosperous, simply because of their dairy interests. Many farmers raise considerable grain for market, but there are also many who raise very little more than what they need for feed on the farm, and some cannot even raise enough for that. Hay is cut from the same land only once every two years except where tame grass is raised.

Cattle, horses and sheep do very well on wild hay, although part of it has been on the ground over winter. But few roots are raised on any portion of the area, and some farmers do not even raise their own potatoes. This is largely because of the scarcity of labor, but in a few cases the farmers are coming to realize their value, and are making efforts to obtain help for the purpose, especially in the more thickly settled parts.

Alfalfa has not been successfully grown and some of the tame grass, such as brome and timothy, yield from two to four tons per acre. Wheat yields from eight to twenty bushels; oats from twenty-five to sixty bushels and barley from twenty-five to thirty-five bushels per acre, while flax is seldom raised except on new land. It then produces from seven to eighteen bushels per acre.

The land has not been changing hands very rapidly recently as the greater part of the farmers are holding on to what they have and waiting for a chance to enlarge their holdings in order that they may keep more cows. The agricultural land ranges in value from $14 to $25 per acre according to the topography, that which is more rolling or hilly selling for the lower prices. There is very little difference, however, in the price of the heavy and light soil. Land which has been improved ranges in value from $18 to $25 per acre, but $20 is about the average selling price. Farther south and west, in the country which is too rough and hilly for anything but grazing, the prices range from $7 to $10 per acre, but the settlers there are very scarce.

The general prosperity of the locality is evidenced in the New Salem bank deposit of $450,000 according to the September statement. This was second only to Mandan and Dickinson among towns west of the Missouri river.

DAIRYING.

The North Dakota Holstein Breeding Association, under the joint supervision of Prof. W. B. Richards of the Agricultural College and a representative of the federal government, was organized in 1909 for the betterment of the dairying industry about New Salem, and neighboring points. The first object of the circuit is to get the farmer to breed cattle better adapted for milk production. There is but one other circuit of the kind in the United States. The project has caused a large increase in the number of cattle in the locality, and has materially raised the standards of dairying. There are fifteen patrons in the association who deliver milk along with others, at New Salem, Youngstown and Rosebud. Their cows must pass the tuberculine test. A complete record of each cow is kept, and her capacity is tested under a varying set of conditions, with an eye to the choice of those giving largest butter yield. The circuit superintendent aims to secure good care of cows, keep records and registration of breeding and records of milk production.

Bad Lands Scene South of New Salem, Tp. 139, R. 85.
A part of the roof of an underground drainage channel has fallen in, leaving a natural bridge. The party crawled or walked in crouching attitude through many of these structures. The land is dotted over with sink holes. Foreground shows the bottom of a creek bed near the source.

John Christiansen's Dairy Farm, New Salem.

The degree of faithfulness of some of the members of the association is rather discouraging, as some of the dairy barns are not very sanitary. They are constructed to accommodate a large number of cows, and the idea of convenience is generally lacking on most farms.

Aside from the milk sold, some men have turned a meat profit by sale of pure blooded stock for breeding purposes. Much wholesome competition is indulged in, and many gratifying results obtained by the participants. A number of fine entries were made from the association in the Morton County fair. William Tellman of Youngtown took second prize record in the Wisconsin dairy cow competition by a production of seventy-two pounds of butter in thirty days from one cow.

The farmers of the section are energetic and thrifty and, while the circuit has been organized but a short time, the results are very encouraging. Once the government has aided in the securing of good breeds, the cattle in the hands of such farmers will prove a valuable asset to the country. The officers of the association are John Christiansen, president; Herman Kroeger, vice-president, and Robert Rush, secretary.

Out of eighty-five creameries in the state Morton county leads with ten, busy and prosperous. Many farmers have been tided through the crop failure of the past season in comparative independence by their herds. This, more than any other factor, has taught the invaluable lesson that the farmer must rely upon a diversified farming in order to win.

The milk is hauled to local creameries, there being two within the area surveyed, one at New Salem and one at Youngtown. Others are located at Almont, Judson, Blue Grass, Rosebud, and at other towns usually sufficiently close to the farms to give a reasonably short haul of milk. However, a few patrons bring milk twelve miles. At these stations the cream is bought, and in some cases the whole milk. A few farmers sell the buttermilk, while many more haul it home to feed to stock. New York prices are realized for the butter fat, while the product is nearly all sent west to Montana and the Pacific coast. The creameries have been operated from three to sixteen years. The average monthly production of butter in pounds ranges from about 3,000 at Rosebud to 9,500 at Youngtown.

The following tabulation of data from four creameries chosen at random from Morton county shows the average production of butter, the number of cows contributing, the length of time the creamery has operated and the number of patrons bringing milk.

Location	Time operated in years	No. Patrons	No. Cows Contributing	Average No pounds butter per month
Almont	3	52	500	5,600
Blue Grass	8	32	300	4,500
Judson	10	26	200	3,380
Youngtown	11	40	600	9,500
New Salem	16	30	450	6,000
Rosebud	10	27	200	3,000

The showing of the Almont creamery is especially good, not having shut down in the three years of its existence. It started with but nine patrons, and it was considered by some to be a venture doomed to failure. It is on a most substantial basis and is helping to develop a section formerly considered not very productive.

SOILS.

The New Salem area was nearly or quite beyond the influence of glacial action and its soils are mostly residual from native country rock, weathered and often much eroded. They are loams of the Morton series.

Just four distinct types of soil were found on the small area covered at New Salem Their boundary lines, as is often the case, were not always marked by change of topography, but were found to be unusually irregular, and quite often to follow creek beds or old washed out channels. In many places no definite boundary lines could be worked out because of the gradual shading from loam to fine sandy loam. Even though these spots or streaks represenated clearly the two types of soil, very little or no difference could be detected between the quality or yield of grain; and the subsoil was often very much the same, although considerably lighter in many cases below the fine sandy loam. The loam probably occupied more territory than any other type, and next to it would come the fine sandy loam The silt loam, which was all found in the southeast corner of the area, occupied only about three and one-half sections, and the clay loam found in only two places large enough to map, occupied only about 300 acres

Pure Bred Holstein Friesian Cattle.

Henry Kroeger of Youngtown, is the owner of the above herd of cattle, and they are known as the Pure Bred Holstein Friesian Cattle. Mr. Kroeger is proud to be the owner of one of the best herds of cattle in the state of North Dakota.

LOAM.

The entire area classified as loam was found to be remarkably uniform except where small spots of fine sandy loam were interspersed. These were extremely small and hardly worth considering, although they might in many cases be very representative of their own type in both the soil and subsoil. That classified as loam contained from ten to fourteen inches of dark brown or black soil, usually quite soft, but the presence of a little coarse grit was not uncommon, and a few places were found where it approached a gravelly loam. It contained a fairly high per cent of organic matter and frequently a high per cent of silt, making an excellent soil. In the virgin soil small nodules of lime were occasionally found, and small pockets of decayed or partly decayed sandstone. Such findings, however, were very uncommon in the soil, but quite common in the subsoil, which was usually lighter in color but very much heavier, and when dry became so hard that to get the augur through it was almost an impossibility. At irregular intervals very thin strata of sand were encountered to a depth of ten feet, and at that depth the percentage of sand in the clay may have been a trifle higher. Most of the area covered by the loam is gently rolling and in a few places it is almost hilly, but in such places the texture is almost invariably coarser.

FINE SANDY LOAM.

The fine sandy loam, bordering upon and intermixed with the loam, is found with very much the same kind of topography but occupies more of the hills.

The soil, which is dark brown or black, ranges from almost a sand to a heavy fine sandy loam, the lighter material being found on the top of knolls and the bottoms of depressions, while most of that found on the intervening land is quite representative of the type. To a depth of nine to fourteen inches the organic matter is quite abundant, imparting the colors mentioned, and with the fine sand making an excellent soil for truck, and one from which fairly good yields of small grains can be secured. The subsoil often becomes lighter as the depth increases, verging closely upon a sand, which may extend to a great depth, or again it may become heavier at a depth of from five to seven feet and continue to a depth of ten feet or more as a sandy clay often verging to a heavy clay. This heavier

subsoil is the more common and in good seasons the crops grown over this subsoil are superior to those grown on that which is lighter. Particles of decayed limestone or that which is partly decayed are very common in this heavy subsoil. From three to five feet practically no moisture was found, and from five feet down it was very scarce, but gradually increased with the depth of the lower land and at ten feet considerable moisture was frequently found in the valleys.

SILT LOAM.

This type was found bordering upon and extending into the rougher country which lay to the south and southeast of the New Salem area. The soil is almost invariably of a brownish or yellowish color and extends to a depth of from nine to twelve inches. It ranges from a heavy silt loam, almost a clay loam, to a very light silt loam verging closely upon a fine sandy loam. It is very uniform, and coarse material is seldom found in it; but small spots are not uncommon where alkali is quite abundant, and, because of the heavier texture, they are locally known as "gumbo" spots. While they do contain a high per cent of clay they do not contain enough to make the typical "gumbo" but are so called largely because of the presence of alkali which is so harmful to the crops whether native or cultivated. However, gumbo and alkaline spots are not large in the New Salem area.

The subsoil which is lighter in color becomes heavier to a depth of about two and one-half feet; there a fine sand is encountered which extends to a depth of seven or eight feet; below this a fine sandy clay is found. Because of the large amount of sand which is found at so slight a depth below the soil, the land is not considered very good for agricultural purposes; but since the native vegetation is good and the rough topography affords some protection for cattle in the winter, it is considered very valuable as a dairy country.

CLAY LOAM.

Clay loam, found only in depressions, is very uncommon and, as a rule, in such poorly drained places that it cannot be profitably cultivated. The soil which extends to a depth of about twelve inches is a heavy black clay loam very rich in organic matter and containing very little or no sand. Particles of decayed limestone are very common in it, and gypsum crystals are often found although not

Folwing well on the farm of Mr. John Heid, three miles north of New Salem, east side of section 3, township 139, range 85. The stone curbing in front of the team marks the location of a spring which keeps the depression in the foreground filled with excellent water.

Dairy Farm and Herd of Herman Kroeger, North of New Salem.

so much as in the subsoil, which gradually becomes lighter in color as the depth increases. Even at a depth of three feet a high per cent of organic matter is not uncommon, giving a black or brown color. Very small amounts of sand are sometimes found. The subsoil as a rule, becomes heavier as the depth increases, and at three feet it is almost impossible to bore into it with an augur. It is quite impervious to water, and after a heavy rain, water may stand on the surface for several days without soaking in more than two or three inches. When dry and hard a plow will not penetrate it. Because of its heavy texture it readily becomes baked, causing the vegetation to wither and often die.

SUMMARY.

The New Salem area is situated in the west central portion of the state. The surface is for the most part gently undulating to rolling. A few hills of the butte type are present. The water table is low and the soils are light and dry.

The climate is similar to that of the other areas described for the western part of the state. The summers are short and hot, with about 120 days frost free; the winters are long and very cold. The air is dry and healthful.

The average rainfall, if properly distributed in the growing season, is able to yield good crops on this fertile soil, when modern methods of cultivation and moisture conservation are employed. The thrifty population is coming to see that the exceptional years may easily be tided over if live stock is made a large asset. Many cattle are kept and dairying is a large industry in this and adjacent areas.

Small grains and hay are the chief agricultural crops. Throughout Dakota corn is coming to be looked upon as demanding a place in crop rotation. It has withstood the drouth in a remarkable manner, and its cultivation eradicates countless weeds. Its largest value is as a roughage, stock food, although much grain can be produced with best approved methods.

Potatoes are seldom grown but when properly cultivated they do fairly well, producing from 175 to 250 bushels per acre.

The best soil on the area is that classified as loam, not that it is much richer, but because its more impervious subsoil retains moisture better. A large part of it is cultivated, and the remainder used for grazing, but some of the fine sandy loam and all of the silt loam are lying idle.

AN INVESTIGATION OF THE SOILS IN THE VICINITY OF McLEOD, NORTH DAKOTA.

Presented as a Thesis for the Degree of Bachelor of Science in Agriculture.

By Harold C. McKinstry, North Dakota Agricultural College, June, 1, 1910.

The McLeod area lies in the eastern part of Ransom county. It is very small, covering only sixteen (16) sections, but is typical of the delta country composing the great sand hill of which it is a part. A large per cent of this area is composed of shifting sand dunes barren of vegetation and of little or no agricultural value, and almost beyond the control of man, except by means of indirect methods.

The sand must in some way be fixed so it cannot blow, ruining all the land over which it passes. How this can be done and the entire county transformed into a productive agricultural country or a great productive forest is the problem; and to that end this study of conditions there and in other similar areas has been made, with the intention of revealing a few of the possibilities, which might aid the development of the country.

GEOLOGICAL HISTORY OF THE AREA.

This area is only a very small part of a great delta covering about eight hundred (800) square miles. The formation of this delta by the Cheyenne river commenced at the time the ice sheet receded, and the river received a great influx of water from the melting ice. This formation marks the place where the flow was first checked by entering the still waters of Lake Agassiz and the gravel and sand deposited in layers. The gravel was first deposited and now extends many feet in most places below the sand. Throughout the area the rough, chopppy, wind-blown dunes are characteristic, forming high hills and deep blowouts, while in the lower areas, where the plant growth has been better, enough organic matter has been formed to make fairly

good soil with the finer-textured material which has been slowly washed in.

The western edge of the delta plain is marked by the town of Sheldon, from which place it extends north about three miles into Cass county. From there the northern edge extends eastward a little to the north of Leonard and eastward and southward near Walcott, Colfax and Barrett on the Great Northern Railway, then south to Mooreton on the Milner branch of the Northern Pacific Railway and a little east of Hankinson. The southern and western edge extends north and west by Taylor, Willard and Swan lakes to a point about four miles northeast of Ransom in Sargent county, and from here northwest to Milnor and to the bend of the river.

WORK DONE ON CAPE COD WITH A SIMILAR PROBLEM.

Sand dunes are usually formed on or near sandy beaches where the wind has full sweep and fine opportunities to keep the sand continually blowing. In such areas almost no plant can thrive because of the blowing sand, which constantly cuts the leaves and exposes the roots, but further inland, where the wind is broken, seeds may germinate and finally a productive forest spring up, which will also serve as a windbreak. When a dune does once become fixed, great care should be exercised not to break the sod which holds it or in any way ruin the forest if one exists there. The trees may also be ruined by fire, but even excessive pasturing of grass lands may often be sufficient to start blow-outs, and then the work of destruction is started. Dry seasons may also do as much or more harm.

Dunes should be fixed for two reasons: To protect property from becoming covered and made useless by them and to convert desert lands into productive forests. In many places where railroads run through dune countries, it has been necessary to spend hundreds of thousands of dollars to prevent the track from becoming covered; and in other places fertile areas have been devastated by the moving dunes. Since all the sand is carried by the wind or rolled along, the method to pursue is to break the wind and bind the sand by some means, for which sand fences, bushes and grass are being extensively used on Cape Cod.

ARTIFICIAL FIXATION OF DUNES.

Foresting is the first method of fixation because it is the most effective, productive and durable when once started, but before a for-

est can be started, the sand must be held in place. This work may be classified in two stages:

1. Preliminary—temporarily holding the sand in place.

2. Permanent—establishing a forest. On the coast strip the work remains in the first stage.

BINDING THE SAND.

There are three methods of binding the sand now in successful use on a large scale.

1. Transplanting sand-binding plants upon the dunes sufficiently thick to form a living cover.

2. Covering the entire surface with some inert material which prevents the wind from reaching the sand. For this purpose manure or straw is often used.

3. Covering the surface with a network of brush fence, which, while not preventing the wind from reaching the sand, lessens its velocity and prevents drifting.

The first case is the most common of the three and should be further commented upon. The first great problem was to get a grass that would thrive on sandy areas and form a sod strong enough to hold the sand against the winds. After many trials with various species, the beach-grass was selected as the best adapted for the purpose. It is a fairly rapid grower and spreads by means of rhyzomes which makes the sod doubly strong and thick. It grows very luxuriantly in areas where the sand is drifting, but if started in undisturbed areas will die out in the course of a few years. It may be transplanted either in the fall or spring. If in the fall, it should not be done until all growth has ceased and the entire plant is dormant, and if in the spring, it should be done before any growth starts. It has been found that wet, foggy weather in the fall is preferable for the work, usually from about September 1st till the ground is frozen. The plants should be two years old and contain at least two nodes, since it is from these places that rhyzomes are sent out. More than two nodes are unnecessary as the plant is not usually set deep enough for them to be of any special use.

Many arrangements have been tried for planting the grass, but the most successful has been to plant in rows, not straight, so the wind can have no chance to sweep out the sand between them for any great distance.

After the grass gains a good start, so that the sand is fixed, young trees should be set out as a start toward the forest, which should and probably will some day cover every sandy area of the kind. Seed planting has failed as the shifting sand either exposes the roots before they get a good start or else they are buried too deep. Many areas of such forests have been started and now are producing thousands of dollars income each year for the government.

After the work has proceeded this far, both the grass and trees must be watched and not allowed to die out anywhere or a blow-out will be started, which will result in the undoing of all the work and necessitate a new start.

Not only is the blowing sand hard on the plants; but, because of its low specific heat, it responds very quickly to any changes of temperature, which has an injurious effect on the plants. Practically the same conditions exist on Cape Cod as exist on the McLeod area. Practically the only difference is that there are local areas on the Cape where coarse sand and pebbles are found, which cannot be moved except by the strongest winds and as a result the sand in these places is held firmly. The deposition of the dunes usually takes the form of successive bars at right angles to the prevailing wind and in time a complete ridge becomes formed along the coast some distance back. The height of the ridge is limited, for after it grows to be about so high the wind is so strong that the sand blows away as fast as it is deposited and no plants have a chance to grow. The dune then begins to move inland. But there is some advantage in this formation, for it serves as a very good windbreak and while it is forming seeds are germinating on the inland side, grass is forming a sod and trees are springing up. So the forests may often reproduce themselves if given an opportunity.

This is a very slow process, however, for the grass must first get a start and form some humus before plants of larger size can grow, so the change comes very gradually and the vegetation gradually becomes that of a larger type.

The shifting sand also fills up bogs and sloughs, but on the other hand, it fills up drainage ditches and forms bogs. These bogs or marshes are not necessarily a sign of waste land, for, in the warmer countries, cranberries do well in them, and in some places the pitch-pine makes fairly good growth, although the whole of the area probably never will become completely forested.

As the sand becomes blown off in many places, it reveals charred stumps and roots, which shows that much of the time existing forest was burned and by the stumps which remain near the coast, it is quite evident that great quantities were used for building ships and as fuel and building material for salt factories.

The grass was probably killed out in many places by being cut and allowed to lie on the ground, which resulted in bare spots and started blow-outs. All such damage is now prevented by the government laws and even the use of land is restricted.

An appropriation for the Cape Cod project of $36,350 was made by the government early in the nineteenth century and work was immediately begun. The planting was done by means of shovels, two men working together. In 1893, $133,770 was expended for the building of a dyke across East Harbor for the purpose of protecting the remaining portions of the harbor from sands carried in by the tides. At that time signs of previous plantings were visible, but most of the grass had died out, probably because most of the plantings had been made on the higher knolls and were uprooted by the wind.

Both spring and fall planting was tried, but fall planting seemed to be more successful, probably for the following reasons:

1. Plants are dormant.
2. Root stocks are stronger.
3. Days are cooler and evaporation less.
4. Specimens are more easily found in the fall.
5. There is an effectual winter of protection gained as the dormant set suffers no deterioration the first winter. Labor is harder to get in the fall and the expense will probably be greater; but, if both the fall and the spring are used for the work the planting season is practically doubled.

Strong vigorous plants were selected and planted both thick and thin, but the extra expense of thick planting made the practice impracticable. Thin planting was done at about $65 per acre. Brush laying was found to be very effective and cost approximately $25 per acre. Brush with the leaves on was the better kind, since they decayed and increased the humus content of the sand.

Beach grass deteriorates very early, so should be made to reproduce early lest its use be limited to the length of its individual life.

Roads are usually made along the low lands, where it is possible and bordered with bushes of some kind to prevent constant drifting while on the higher ground brush and rubbish are spread on the roads.

The sand is of little commercial value; timber is grown only slowly, so the only immediate income must be from the hay crop. This is also limited, however, for, if cut too frequently, drifting is again started.

The government has now set aside several large areas for timber and game reserves and for the reclamation of the Cape Cod sand dunes. The state and government spent respectively $31,927 and $162,019 (U. S. Dept. of Plant Industry; Bul. 65.)

TOPOGRAPHY OF M'CLEOD AREA.

The topography ranges from a very gently rolling prairie to rough, irregular sand dunes of various heights. The prairie country is usually rather low and in many places large areas are below the water table or so near to it, that in the wet season sloughs are formed. The land in such places does not become boggy and sticky as is usually the case, but remains so firm that a team can be driven over it anywhere.

From the sloughs and prairie the land generally becomes higher, and as the elevation increases the topography becomes rougher and finally develops into a series of very irregular sand dunes over which a wagon cannot be driven at all. There seems to be little or no special topographic arrangement, but the sloughs, dunes and prairie are mixed together. That is, one can look for a deep slough anywhere between the dunes or may expect to see an immense dune rising alone in the middle of a prairie area, bare of vegetation of any kind, but surrounded by prairie grass or in some cases by a slough supporting a rank growth of sedge and rushes.

VEGETATION.

The tops and a large part of the sides of the dunes are entirely bear or else have only a few scattering spears of sand grass insufficient to hold the sand from blowing. The grass gradually becomes heavier, however, toward the lower ground until the rushes and sedges of the sloughs are reached. The prairie grass or sand grass which grows on the more level areas below the dunes forms a light sod and is the only grass which ammounts to very much as pasturage or hay. It is fairly good in quality but very limited in quantity as it is short and not a very rank grower.

The slough grass may be divided into three classes. The first and most plentiful is a sedge which grows in the meadows and near the edge of the water. It is useless for food either green or cured, being woody and non-digestible, although it contains a high per cent of water. It is so useless that every winter large numbers of cattle and some horses die with the manger full of this hay in front of them, although the hay taken from the higher lands is fairly nutritious. The second class is a coarser plant, such as the cat-tail, and the third is composed very largely of bullrushes and strictly water plants.

Small groves of scrub oak, willow and cottonwood are scattered sparingly over the dune areas and when started they make fairly good growth. The prairie fires, however, which sweep the country nearly every year kill many trees, and prevent any others from getting started.

WATER SUPPLY.

Aside from an annual rainfall of about eighteen inches, which all soaks into the ground as soon as it falls, all the water from the highlands farther to the east drains through this sandy area toward the Cheyenne river and so keeps the water table very near level with the surface over whole area. This water is always at a low temperature, since very little heat is absorbed from the sun by the sand; and a well can be made by means of a sand point in one or two hours. Good water can be obtained at a depth of five or six feet.

In mapping the McLeod area, the distinction between soil types is necessarily very fine; and, while most of the samples fall under the same type in the mechanical analysis, they were mapped differently because of topography features or some slight difference in the physical conditions.

SANDY LOAM.

That mapped as sandy loam is the second best soil and covers about one-third of the total area. It is found principally in the low places, or at least only a short way above the water table, and as a rule quite a considerable distance from the dunes. Such land is usually slightly rolling or level, more often the latter, the boundary lines between it and other types are usually quite distince, being marked not only by the change of the soil type but also by the contour.

Mechanical Analysis.

Sample	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Total Sand	Silt	Clay	Organic matter	Hyg. Water
9	0.25	1.40	10.60	60.50	18.10	90.85	3.56	2.88	2.62	0.30

Location: N. W. ¼ of section 16.

Percolation Tests (duplicates).

Wgt. of tube	Total Dry Weight	Weight of dry soil	Total weight saturated	Total wgt. Drained	Wgt. of water retained	Per cent. of water retained
223	978	755	1190	1180	425	56
219	915	726	1161	1154	428	57

The vegetation is also of a much finer quality, but far from good, and is of very little use as hay. The soil is easily worked when once put into condition, but soon goes back to sod if not well tilled, because of the excessive supply of water.

SILTY SAND.

This type covers only about 150 acres and was slightly higher than the average sandy loam, although not as high as most of the sandy prairie. It is only gently undulating and is very much the form of a ridge extending out into the lower land and gradually dying out. The grass on it is a rich prairie grass and, because of its superior feeding qualities forms a remarkable contrast with that of the land adjoining. The water supply is better near the surface of this soil, since the texture is so very much finer that the capillary water is more plentiful in spite of the fact that the surface is further from the water table. The subsoil extends to a depth of from three to five feet. Unlike the subsoil in any other part of the area, it contains a larger per cent of silt and very fine sand, making it soft and mellow. The boundary between the soil and the sand below is not sharp and well marked, but one gradually blends with the other to such an extent that it is often difficult to tell where to draw the line. While this type covers very little territory, it is better than the sandy loam because of the firmer subsoil.

Mechanical Analysis.

Sample	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Total Sand	Silt	Clay	Organic matter	Hyg. water
No. 2	0.05	0.82	5.9	50.76	15.33	72.86	17.19	8.69	0.52	1.74

Location: S. E. ¼ Section 13.

Percolation Test (duplicates).

Wgt. of tube	Total dry weight	Wgt. of soil	Total weight saturated	Total wgt. drained	Wgt. of water retained	Per cent. of water retained
229	970	741	1265	1175	484	68
231	915	684	1312	1220	536	76

SANDY MEADOW.

Sandy meadow is merely the low wet land where but little organic matter has been formed; and from the surface down to a depth of twenty feet or more there is practically no change, either in the texture or color of the sand. These meadows are usually level, although occasionally small covered grass dunes are a few feet in height arise from the surface, probably having been formed by an occasional dry year.

Mechanical Analysis.

Sample	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Total Sand	Silt	Clay	Organic matter	Hyg. water
No. 1	0.17	7.07	3	53.85	15.03	92.74	2.73	1.98	2.08	0.66
No. 3	0.99	2.94	4.	51.91	23.90	94.34	3.31	1.47	0.35	0.40
No. 7	1.35	6.75	4.	50.80	7.85	80.75	5.40	1 60	1.97	3.30

Location:
No. 1 N. W. ¼ Section 33.
No. 3 S. E. ¼ Section 34.
No. 7 S. W. ¼ Section 33.

Percolation Test (duplicates).

No.	Wgt. of tube	Total dry weight	Weight of Soil	Total wgt. saturated	Total wgt. drained	Wgt. of water retained	Per cent. of water retained
1	232	1004	772	1375	1273	506	64
	226	1029	808	1385	1297	494	61
3	234	1046	812	1412	1325	513	63
	237	1059	822	1420	1334	512	62
7	229	937	708	1168	1163	455	64
	224	943	719	1177	1171	452	62

SANDY PRAIRIE.

The only difference between the sandy meadow and sandy prairie is in the topography. The latter is somewhat higher, very dry, and gently rolling. The sod is very light; and, wherever broken or worn through, a blow-out may start. In the amount of organic mat-

ter and texture of the sand there is no perceptible difference as compared with the sandy meadow.

Mechanical Analysis.

Sample	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Total Sand	Silt	Clay	Organic matter	Hyg. water
No. 4	0.05	1.10	8.05	65.20	17.6	92.0	5.29	1.48	0.26	0.73
No. 8	0.40	6.40	14.10	42.00	21.0	84.30	10.57	1.57	2.55	0.30

Location:
No. 4 S. W. ¼ Section 35.
No. 8 S. E. ¼ Section 15.

Percolation Test (duplicates).

No.	Wgt. of tube	Total dry weight	Weight of Soil	Total wgt. saturated	Total wgt. drained	Wgt. of water retained	Per cent. of water retained
4	222	987	765	1370	1285	520	68
	229	1000	771	1375	1278	507	65
8	236	933	696	1182	1177	481	68
	226	953	727	1177	1173	446	61

DUNE SAND.

The most useless and harmful portion of the whoe area is that composed of the sand dunes. The topography ranges from gently rolling to steep, irregular dunes through which it would be an impossibility to drive with a buggy. A large number of these dunes are barren of vegetation and continually shifting, leaving barren, sandy paths behind. There is, however, much of the sandy area covered with a thin covering of sand grass, which makes a fairly good pasture where thick enough, but it is easily killed out by dry weather and too close pasturing.

Probably the only reason why those dunes are not now covered with productive forests is because of the fires which sweep across the country every year, killing all young trees which may have gained a start. In the more protected regions, small groves of trees are growing and they would soon spread over the entire area if only given a chance.

Mechanical Analysis.

Sample	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Total Sand	Silt	Clay	Organic matter	Hyg. water
No. 5	0.05	1.60	11.60	57.65	22.60	93.50	2.75	0.70	2.87	0.25

Location:
N. E. ¼ Section 21.

Percolation Test (duplicates).

Weight of tube	Total dry weight	Wght. of dry soil	Total wgt. saturated	Total wgt. drained	Wgt. of water retained	Per cent. of water retained
224	1030	806	1357	1269	463	57
236	990	754	1410	1322	568	75

The methods of managing the sand dunes have been discussed and while the methods here stated have not thus far been followed out in the McLeod area, there seems to be no reason why they would not be successful.

Even in those soils containing a higher per cent of organic matter, good drainage and a larger amount of organic matter would greatly improve conditions. In most of these soils the water table comes so near the surface that the plant roots are drowned, except for those plants composing the native vegetation, which are accustomed to so large an amount of water. Just how the country may be drained is a very difficult problem because of its peculiar topography and the problem of keeping the ditches open when once dug. Much leveling would be necessary and concrete or wooden curbing would be needed to hold the sand from washing into the ditches.

By the preceding table it may be seen that the texture of the sand is very similar over the entire area, and most of the difference in types lies in the topography and organic matter content.

The resutls obtained from the percolation tests are by no means accurate as compared with the actual field conditions, but the com- in the compactness of the soil. Possibly most of the error in the duplicates is due to irregularity.

PRESENT AGRICULTURAL CONDITIONS.

As compared with investments in more fertile parts of the state, the investment in farm property in the McLeod area is not, as a general rule, very heavy, although a few of the more prosperous farmers or land men of the neighboring communities own fairly large tracts. Most of this land is lying idle at the present time and is increasing in value very slowly, so there is practically nothing to be gained by holding it. In fact, there has been so much money lost there by investments in the last few years that to secure loans on any of the land is almost an impossibility.

The lower and more level areas support fairly good crops and on such land an occasional farmer may be found who has at least made a good living and possibly owns his farm.

Very little attention is given to crop rotation by the majority of farmers since most of them live from hand to mouth and feel that they can spend no time or money in trying to change the country to any apppreciable extent.

The churches and schools scattered over the country are not very numerous, but easily accommodate the people who attend. Most of the inhabitants are Scandinavians, although a few Americans are found hanging on and waiting until they make enough money to get out, or possibly waiting only with the hope that the land will commence to boom.

The amount of live stock is very limited and only a few dairy cows are kept in the neighborhood. A few beef cattle are raised near McLeod, but, due to the poor quality of hay and scarcity of grain, they cannot be fattened enough to be marketed as fattened stock, but must go as feeders and consequently at a comparatively low price.

Sanitary conditions are good as a rule, because of the rapidity with which all drainage water percolates through the soil and the constant movement toward the river of the gravitational water.

Farm labor is very scarce, which is probably due to the fact that very little is required and all the laborers go to the better farming communities. The few farms that are worked with any system are small enough so that the owner can do most of the work himself.

Prices paid for farm labor range from $25 to $35 per month or $1.50 to $2.25 per day through haying and harvest time. Because of the scarcity of help at the right time, it is often necessary for the farmers to take anyone they can get and pay the wages asked.

MARKET AND TRANSPORTATION FACILITIES

The main line of the Soo railway runs across the area northwest and southeast. Until the fall of 1909, there was no depot whatever, and freight could not be shipped to or from the place without considerable inconvenience. Since the depot has been erected agents have been kept there and shipping facilities very much improved. An elevator has been erected and grain can be shipped directly to the cities.

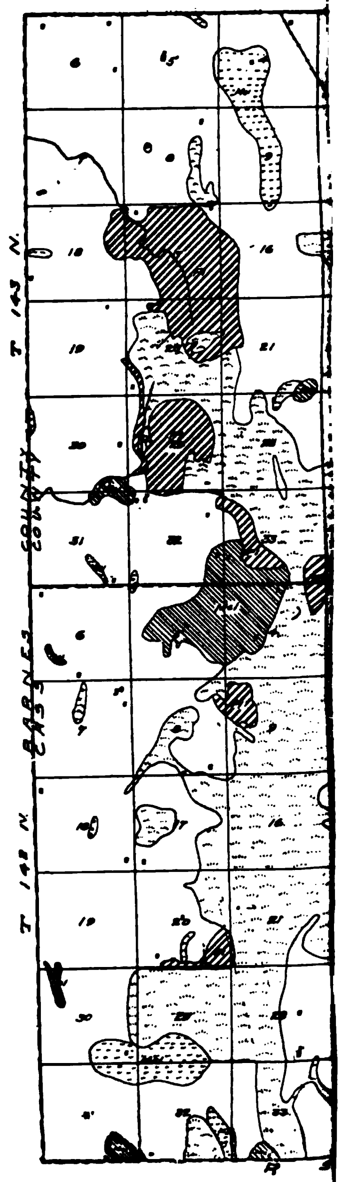
Wagon roads are not very good on the lower ground, as the sand blows so badly in the dune regions that the roads soon become filled in, and the moving of heavy loads is almost an impossibility.

SUMMARY

Up to the present time no work of investigation has been done on the McLeod area at all and the work that must be done must necessarily be estimated from what has been done in areas of similar nature, such as Cape Cod. In both places, the soil, if it may be called such, is water formed, and the wind is doing practically the same work in each area. The climate, of course, is quite different, but the length of the growing season is not very different.

Over the entire area of McLeod, the general nature of the vegetation is extremely poor in quality so far as feed value is concerned, although an occasional spot may be found where the grass is fairly nutritious.

There is no question but what a productive forest could be produced in this if only the proper methods were followed and these might probably be taken from Cape Cod work. However, prairie fires must be prevented in the first place. They now sweep the country every year, and only by the aid of all inhabitants can the country be kept free from them and the barrenness of the country transformed.



SOIL SURVEY OF THE PAGE AREA, CASS COUNTY, N. D.

By Frank Bennett of Federal Soil Survey.
Assisted by
Harold McKinstry of the Agricultural and Geological Survey of North Dakota (1909.)
With certain additions by the Director.

DESCRIPTION OF THE AREA.*

The Page area consists of the four townships in the northwest corner of Cass county; townships 142 and 143, ranges 54 and 55. Steele county lies on the north and Barnes on the west. The area is named from the principal town, Page. Dartmoore is in the area and Ayr is on the south boundary. A line of the Great Northern railroad runs diagonally across the area through these towns, giving good transportation facilities.

The Maple river runs south through the western side of the area. The country is flat to gently rolling, as is all of this section of the state. Some areas of the choicest land are so level as to be too wet for cultivation in wet years, and thus demand immediate drainage.

CLIMATE.

The long cold winters and short hot summers, characteristic of North Dakota and Minnesota, prevail in the area. The rainfall is sufficient for the crops in all but very exceptionally dry years, chiefly because it comes largely in the growing season. The long days of the growing season give ample sunlight to develop most crops. In fact the area is in the famous wheat belt of North Dakota-Minnesota.

AGRICULTURE.

The methods of agriculture practiced in the area surveyed are characteristic of those of the eastern part of the state. Grain has been continually grown on the same land since the country was first opened up for agricultural purposes. This one-crop system,

*This description was written by Mr. Bennett before the recent reclassification. Most of the Marshall types here described are now generally recognized as Carrington types.

that has been practiced for so many years, has caused somewhat of a decrease in the yields, especially on the lighter soils such as the Marshall fine sandy loam.

This deterioration in the soil has been realized by the farmers during the past few years, and to a certain extent some of them have been practicing a rotation of crops and summer fallowing, in order to get better yields. It is found that these methods will increase the yields from five to ten bushels per acre. Corn, timothy, and clover are generally used in the rotation, corn being the most important. In most cases the acreage devoted to crops besides grain is very small, which means that it would take a good many years to rotate an entire farm. If more stock were kept on the farm a greater acreage of corn and tame grasses could be grown.

At the present time a great many farmers pay no attention to the barnyard manure. It could be used to great advantage on the Marshall fine sandy loam and the Marshall gravelly loam. The straw stacks are always burned with the exception of a very small percentage that is used for feed and other purposes. If this straw was allowed to rot and was distributed over the land it would be very beneficial to the soil. The farmers make the excuse for burning it, that they lose the yields from the land while they are waiting for the straw to rot. Where a stack of straw has been burned it is clearly defined when the next crop is harvested. The soil is so rich in plant food in such places that the grain grows very rank, being practically all straw; in most cases this falls down, before it can be harvested, and the result is that practically no grain is secured.

If this concentration of plant food were distributed over a much greater area it would be found that an increase in the yield would be secured, instead of receiving practically no returns from the very small area occupied by the straw stack.

The lighter soils, such as the Marshall fine sandy loam and the Marshall gravelly loam, are best adapted to the Durum wheat, as it does not require so much moisture as the other varieties. The Marshall fine sandy loam is also especially adapted to corn. Being a light soil, it warms up early in the spring; and the corn grows more rapidly and matures earlier than on the heavier soils. The Marshall fine sandy loam is adapted to early truck for the reason mentioned above in regard to corn. The Marshall gravelly loam gives a quick growth of all crops in the spring; but, on account of its topography and porus condition, it does not supply sufficient moisture during the summer to produce good yields. The heavier soils,

such as the Marshall loam and Marshall clay loam, give better yields; but there is more danger of frost. The Marshall loam is the best soil in the area for general farming. The greater portion of it is fertile, and produces good yields of small grain, corn, and potatoes.

The large area represented as meadow west of Page, if drained, would make a very productive soil. Surveys have been made with the purpose of draining this section. If this drainage system should be developed, it would add to the value of the Page loam, the most of which borders the meadow. After this area is drained it would have to be sown in flax for two or three years, as the soil would be so fertile that grain would be principally straw, and would fall down. This soil would produce excellent yields of corn, but it would be late maturing, which would cause it to be subject to frost. While comparatively little attention is given to truck in the area, this soil would produce enormous yields of cabbage and onions. It would also produce good celery.

The land suitable for agricultural purposes ranges in price from $30 to $50, depending on the improvements or location. The Marshall loam demands the highest price of any of the soils. The large farms are gradually being cut up into smaller ones. People are coming in from Illinois, Iowa, and some of the states further east. As a general rule, these farmers are practicing a rotation of crops, raising stock, and making every effort to improve the soil. Such people will be of much value to the community, and, if the people will follow the scientific methods of farming, it will be only a short time before the yield of grain per acre will be greatly increased, and the land made more valuable.

Under the present methods practiced by the greater portion of the farmers, the following estimates show the range of the yields of the various types: Marshall loam, wheat from thirteen to eighteen bushels per acre, oats from thirty to forty bushels. The Marshall clay loam depends on the season; in a dry year the yields are greater than on the Marshall loam, but on an average this soil will produce about sixteen bushels of wheat per acre and thirty bushels of oats. The Marshall fine sandy loam on an average produces from ten to fifteen bushels of wheat per acre and from twenty-five to thirty-five bushels of oats per acre. The Marshall gravelly loam occurs in rather small areas, and the yields are hard to estimate, but they are the lowest of any of the cultivatible types. The

Page loam produces excellent yields during a dry season; but, when there is an excess of moisture, crops suffer and the yields are small. The yields depend to a great extent on the farmer as well as the soil type. Some of the farmers produce as high as twenty-five to thirty bushels of wheat per acre.

Some flax is grown in the area, the yields ranging from about eight to twelve bushels per acre.

The area surveyed is a prosperous farming section, but by practicing the proper methods, it could be made more prosperous, and the price of land would rapidly advance.

SOILS.

Marshall Gravelly Loam.

The soil of the type to a depth of six inches is a dark brown gravelly loam. The subsoil immediately below this to a depth of three feet or more is a grayish brown coarse sand and gravel. The depth and character of this soil depends somewhat on the topography. The type occurs in narrow ridges or rounded knolls. At the top of these ridges and knolls the soil is often very thin, sometimes not being over two or three inches deep. The gravel content is also much higher than along the slopes, it being frequently the case that it was impossible to bore a hole three feet in depth. In such cases the soil is lighter in color, being almost gray. This is due to smaller percentage of organic matter. In some instances small spots were found where this subsoil contained a high percentage of silt, giving it the characteristics of a light gravelly silt clay. This gives the subsoil better moisture holding properties, which causes it to naturally produce better crops than the main body of the type. Such areas were very small and could not be represented on the map.

The depth of the soil decreases and the gravel content increases as the elevation increases. The greater portion of this type occurs on the narrow ridges which rise abruptly and are clearly defined. The most extensive one is found west of Page, exteding north and south for a distance of five or six miles. The round knolls are quite numerous but are generally comparatively small. There were quite a number of these knolls that were too small to represent on the map, ranging from about one-fourth to two acres in size.

Page Loam.

The Page loam to a depth of twelve inches is a black loam very rich in organic matter. The first few inches of soil contain such a high percentage of organic matter that it has some of the characteristics of muck.

The subsoil from twelve to about eighteen inches is a black silty clay; below this to a depth of thirty-six inches is found a gray silty clay. This type in practically every case is associated with meadow, being bordered by it on at least one side.

The topography of the Page loam is level or flat, and the drainage, is insufficient during a wet season. During a dry season, such as would cause crops to suffer on the most of the other types, this soil produces excellent yields. It produces good crops during an average season, but better drainage would cause crops to be more certain. The type might be considered a gradation between the Marshall loam or Marshall clay loam and meadow, although the soil is more like that of the meadow. The high percentage of vegetable matter in this soil makes it the most fertile of any of the cultivated types, but a better system of drainage is needed.

Meadow.

The term meadow has been used for land that is too wet for cultivation. It occurs as broad acres along sloughs, or as small spots in the form of pot holes or depressions. In some cases the pot holes were too small to represent on the map, being only from one-fourth to one or two acres in size.

The pot holes are scattered all over the area. The majority of them get dry enough during the summer for cutting for hay. Some hay can be cut around the edges of all of them, although they may be wet in the center. By far the greater portion of the type is found in the western part of the area extending north and south. It is about nine miles in length and ranges in width from about one-half to two miles.

If the type were drained it would be something similar to the Page loam. It consists of a black loam, being quite mucky, due to the high percentage of organic matter. This extends to a depth of from ten to eighteen inches. Below this is generally a grayish black or gray silty clay. At the present this type is used only for grazing and cutting hay. A large portion of it is covered by water the entire year and cannot be used at all.

Marshall Fine Sandy Loam.

The soil of this type to a depth of eight inches is a dark brown fine sandy loam. Below this is a yellowish gray silty clay, containing some fine sand. Both the soil and subsoil occasionally contain a little gravel.

Occasionally there are very small patches of gravelly loam scattered through this type which are in the form of knolls.

The texture of the sand in this type is principally fine and very fine, although in the southwestern corner of the area there was a considerable amount of medium sand in the soil, but this was the only place where it was found. The topography here was not so rolling as that of the main type. Occasionally borings were taken where the subsoil was very sandy, and in a few cases it was almost a sand. This was most noticeable along the southeastern border of the area.

The topography of the type is rolling, and the most of it occurs in high ridges or knolls. The percentage of sand in both the soil and subsoil varies with the topography, more sand being found on top of the ridges than along the slopes. In such cases the soil does not extend to so great a depth, the depth decreasing with an increase of elevation.

Marshall Clay Loam.

The soil of the Marshall clay loam to a depth of ten inches is a black loam, containing a comparatively high percentage of organic matter. The subsoil to a depth of thirty-six inches is a grayish black clay containing a rather high percentage of silt. The transition from the soil to the subsoil is rather gradual. The color becomes lighter as the depth increases. Between twenty-five and thirty-six inches the subsoil is gray, although it is sometimes a yellowish gray. There is occasionally a very small percentage of fine sand in both the soil and subsoil.

The topography of this type is level or flat. The soil is very productive, but the lack of sufficient drainage makes it less desirable than the Marshall loam. During a dry year the crops are far superior to those of the Marshall loam; but, when there is a wet season the Marshall clay loam suffers from an excess of moisture. Practically all of the type is found south and west of Page. It is always associated with meadow; areas of meadow either border it, or

spots are found scattered through it. The area covered by this type is next in size to the Marshall loam, with the exception of meadow.

Marshall Loam.

This type consists of about ten inches of black loam containing a small percentage of fine sand. The subsoil from ten to thirty-six inches is a yellowish gray silty clay occasionally containing a very small percentage of sand. This soil covers more of the area than all of the other types combined. The surface soil is very uniform, the only variation being found being in the sand content. The highest percentage of sand was generally found on the most elevated areas.

The subsoil varies more than the soil. It may be a silty clay containing but very little sand. Where the subsoil is very silty, the sand is generally very fine. Coarse sand is sometimes found in the subsoil, and also fine gravel. This material is not in sufficient quantities to cause any material difference in the moisture-holding qualities of the subsoil. The topography varies from level to rolling. On the level areas the soil contains very little sand, and extends to a greater depth than that found at higher elevations.

The highest percentage of sand in both the soil and subsoil is generally found on the ridges. This does not hold true in all cases, as the soil on the ridges is often almost free from sand; the sand does not extend to the depth that it does in the more level areas. The depth of the soil decreases with an increase of elevation. This change is so gradual that it is not noticeable except on the crest of some of the highest ridges or knolls. Such spots are very small, and are not large enough to represent on the map. The soil does not extend over five or six inches and has a lighter color than that of the main type. On these ridges or knolls are sometimes found small spots of the Marshall gravelly loam, which were too small to represent on the map. They generally occur in the form of knolls and are only about two or three rods wide.

There is another phase of this type represented on the map as meadow. This is in the pot holes. They are too wet for cultivation, but are only a few rods in width. The Marshall loam is the most desirable soil found in the area.

SOIL SURVEY OF THE BEACH AREA, NORTH DAKOTA.

By Frank Bennett of Federal Soil Survey.
Assisted by
Harold McKinstry of the Agricultural and Geological Survey of North Dakota (1909.)
With certain additions by the Director.

DESCRIPTION.

The Beach area, consisting of nearly three townships, lies on the western border of the state along the Northern Pacific railroad in Billings county. The half townships 139 and 140, formed by the state line running through range 106, all of township 140, range 105, and nearly all of township 139, range 105, were surveyed.

The principal settlement, Beach, has grown from a railroad station to a town of about 1,000 inhabitants. There are three banks. The merchants do an enormous business for a town of its size. The area is located on what is known as the Golden Valley. The topography ranges from level to rolling, which makes it a beautiful country. There is practically no waste land.

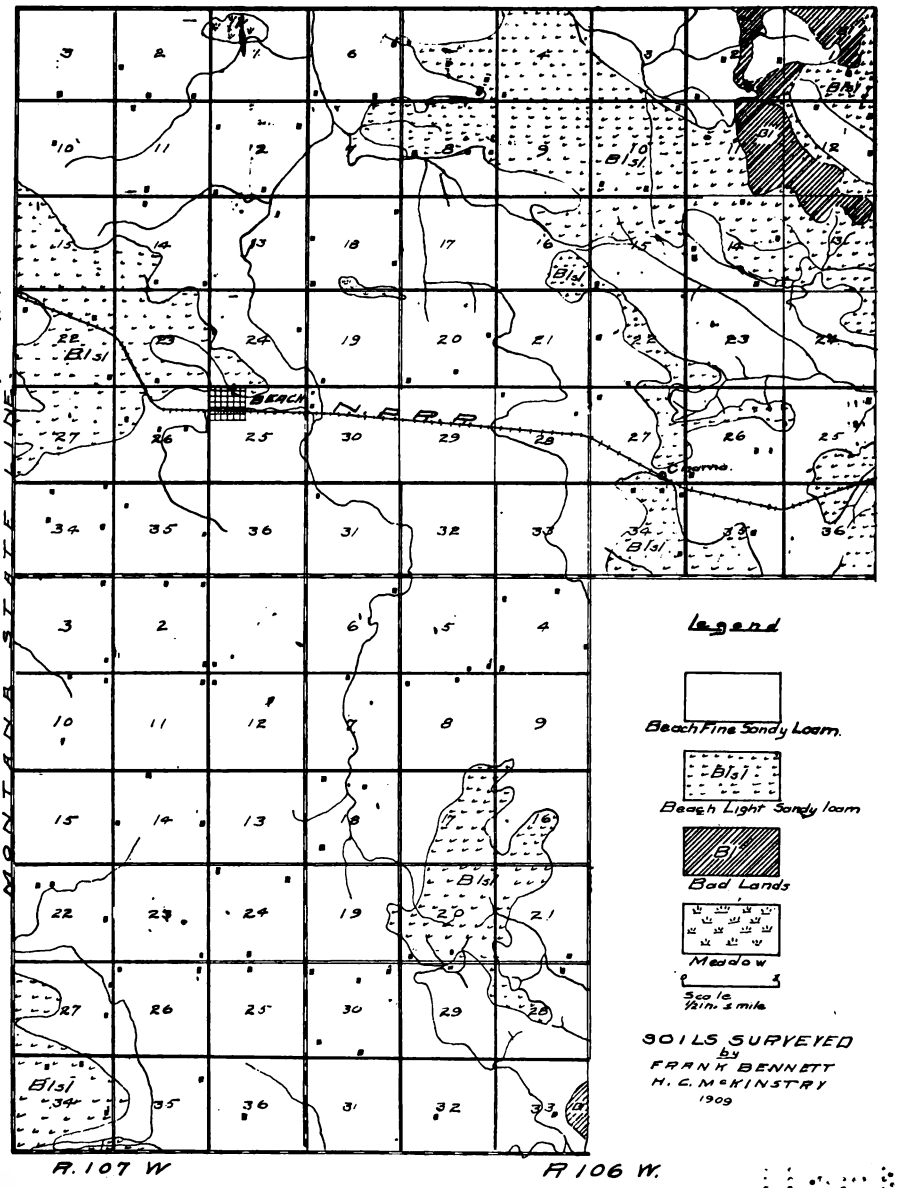
AGRICULTURE.

The country surrounding Beach, or the territory included within the survey, is just in its infancy as an agricultural district. The first attempt to develop this country into a farming community was about seven years ago. Until this time it was generally thought that the rainfall was insufficient to produce good crops during an average year. During this period of years there has not been a crop failure. It has only been in the last three years that agriculture has been extensively developed; in fact the country has been made practically what it is during this time.

In a general way, there is practically but one type of soil in this valley, which is a fine sandy loam, and is locally called "brown loam." This type has different values which vary with the topography. Gravel and sand occur, but each phase has a high percent of silt, in fact, in spots the soil becomes a silt loam.

SOIL MAP
BEACH AREA
Billings County No. Dak.

AGRICULTURAL AND ECONOMIC
GEOLOGICAL SURVEY OF NORTH DAKOTA
HERBERT A. HARD, DIRECTOR.



Legend

Beach Fine Sandy Loam.

Bl 1 — Beach Light Sandy loam

Bl — Bad Lands

Meadow

Scale 1/2 in. = 1 mile

SOILS SURVEYED
by
FRANK BENNETT
H. C. McKINSTRY
1909

The Beach fine sandy loam is the most productive soil in the area. A large portion of the Beach light sandy loam produces just as good crops at present, but the soil is not so deep and its lasting qualities not so good. The fine sandy loam on account of its topography is also better able to stand a drought in case one should occur. As in all new countries, there is no thought of crop rotation at present. Wheat, oats, barley and flax are the crops grown. On an average, wheat yields from about twenty to twenty-five bushels per acre, oats from forty to fifty, and flax from twelve to eighteen. When the soil is handled properly, the yield goes higher. If the farmers could be induced to practice scientific methods while the country is new, this Golden valley could always be made to produce the excellent crops that it is growing at present.

The rotation of crops, summer fallowing, and the raising of live stock cannot be too highly recommended. In case of a crop failure, under the present methods the farmer has nothing to fall back upon except the merchant. Many of them do not grow enough potatoes for their own use; and, if they do, they give them very little attention.

Only one or two small patches of corn were seen in the area. This would be an excellent crop to use in rotation. Corn should be planted on the light soils, such as the Beach light sandy loam or Beach fine sand. The soils are better adapted to corn on account of its maturing more rapidly. Practically all of the soils are comparatively light in texture, and corn should mature during an average year, so it is likely that a failure would seldom occur.

The Durum wheat should be sown on the higher and lighter soils such as the Beach light sandy loam, and Beach fine sand, as its moisture requirements are not so great as that of the other wheats.

The soils of the area are especially adapted to potatoes. They yield from 150 to 250 bushels per acre and are worth from 50 cents to one dollar per bushel. Small fruits also yield excellent returns. It was seldom the case that a patch of tame grass was seen; and it will probably be several years before it will be grown, as wild hay is still plentiful. Under the present rapid development of the valley, it will be only a matter of time until all of the wild land is under cultivation; and the farmers will be compelled to grow corn and tame grasses for feed. The sooner this time is reached, the better off the farmer will be, as he will be forced to rotate to a certain extent.

Very large quantities of flax are grown in the area, as the land is always sown to this crop the first year the sod is broken. The traction engine is used to a considerable extent on the farms for plowing, etc. Some farmers have put their grain on the market by means of these engines, using no teams at all.

The prices of land range from $20 to $55 per acre. This is within reasonable distance of town. Where it is from fifteen to twenty-five miles from the railroad, it can be bought from $17 to $20 per acre.

The valley as a whole is a very desirable region, and its growth has been continuous. Well built modern farm houses and barns are replacing the first homes, which were shanties. If crops continue to be as good as they have been in the past, the Golden Valley will be one of the most prosperous sections of western North Dakota.

SOILS.

BEACH LIGHT SANDY LOAM.

This type to a depth of about eight inches is a light brown silt-sand loam underlain by a gray silt-sand that extends to a depth of three feet or more. The subsoil occasionally contains much very fine sand. Pockets of this very fine sand are sometimes encountered at twenty to thirty inches and more frequently at a depth between four and six feet. In almost every case this sand occurs on knolls or on the highest elevations. A few very small areas were encountered that were too small to represent on the map where the surface soil contained a considerable amount of very fine sand. These spots were also found on knolls. There was no regularity in the occurrence of this sand on the knolls.. The largest area would not cover over one or two acres, while the greater portion of them were only a few rods wide. There were also a few small spots of this type on the knolls that contained some gravel.

Along the most elevated ridges sometimes occur what is locally known as "buffalo wallows." These are small spots varying in width from a few feet to about twenty or thirty feet, and contain very little or no vegetation. The surface soil has been removed through some cause and on an average they are about six to twelve inches below the adjacent soil. They are commonly supposed by the inhabitants to have been formed by buffaloes. Many were probably formed by wind action. A peculiarity about them is that some of them contain a small percentage of alkali, and are rather wet, even during the summer. However, the greater portion of them are dry.

The topography of this type varies from gently rolling to rolling, although none of it is so rolling as to cause any difficulty in its cultivation. The material contained in the soil of this type is almost the same as that of the Beach fine sandy loam, one difference between the two types being the topography. The soil of the Beach light sandy loam does not contain so much organic matter, which is due to a lighter growth of grass, as it will not stand a drouth so well. Much of the vegetable matter that should have been accumulated in this soil has been washed from the slopes into the valley or onto the Beach fine sandy loam.

Beach Fine Sandy Loam.

The soil of the Beach fine sandy loam on an average consists of twelve inches of brown sandy loam underlain by a yellowish brown sandy loam to a depth of three feet or more. There is very little difference in the soil and subsoil with the exception of the color, the soil being darker, due to a higher percentage of organic matter. So great is the per cent of silt in all these types that they were at first called silt loams by the field party. The following mechanical analysis shows that we have a fine sandy loam with a high per cent of silt:

Mechanical Analysis of Beach (Morton) Fine Sandy Loam.

	Hygroscopic Moisture	Fine Gravel	Coarse Sand	Med'm Sand	Fine Sand	Very Fine Sand	Silt	Clay
Soil	2.825	0.15	0.86	0.50	10.99	38.12	36.82	11.20
Subsoil	2.325	0.03	0.24	0.24	9.03	34.09	38.56	14.54

The subsoil is more compact, and this makes it appear heavier than the soil, but when exposed to the air there is very little difference in the structure. The subsoil contains a little higher percentage of clay and silt than the soil. The transition of the soil to the subsoil is so gradual that it is hard to determine a definite line between the two. In most cases the lighter color of the subsoil does not appear until a depth of eighteen or twenty inches is reached. In a few cases a small percentage of very fine sand was found in the subsoil at about thirty-six inches. This type is very uniform and is practically all in one phase, the only difference being in the topography which varies from level to slightly rolling. On the level areas the soil contains a little organic matter which gives it a slightly darker color. It also extends to a greater depth. This organic mat-

ter slowly decreases as the land becomes more undulating. The level areas would be slightly more desirable in case of drought, on account of their being slightly more capable of holding moisture.

The difference between the above types are so slight that they are hardly noticeable. They should perhaps be considered phases of one type. There are of course variations in the crop yields on the types, but this is principally due to the methods of cultivation.

The Beach fine sandy loam is the predominating soil of the area, covering as much if not more than all of the other types combined. This type is also the most productive one in the area and is a high grade of fine sandy loam, grading into a subsoil that is a true loam.

Meadow.

Meadow represents a type that is too wet for cultivation. The larger areas of this type afford a good growth of grass which is cut for hay, while the most of the very small areas represent pot holes. These pot holes are sometimes quite numerous, many of them covering only from one-eighth to an acre. They occur principally in the Beach fine sandy loam. They give a field a bad apppearance. Some of the streams represented on the maps are a chain of pot holes following very narrow valleys. Such streams act as drainage outlets, when there is an abundance of water. The pot holes are generally wet until the late spring or summer, while in many cases the land is cultivated between them. The soil of this type is slightly heavier than any of the other types, due to the accumulation of the very finest material. It is a silt loam, being slightly sticky, and is very rich in organic matter. This gives it an almost black color. The subsoil is a yellowish sticky silt loam.

Beach Gravelly Loam.

The Beach gravelly loam to a depth of eight inches is composed of a light brown gravelly loam which is underlain by a yellowish brown fine sandy loam to a depth of three feet or more. The surface soil is silt and gravel. Very little gravel was encountered in the subsoil, practically all of it being found in the first twelve inches of the surface soil. Practically all of this type occurs in the northern part of the area along Beaver creek, although there are a few very small spots scattered over other parts of the area. This soil occupies a rather rough topography, being found on high, rounded knolls, or it occurs as broken slopes along the streams. Occasionally there are

spots of this type too small to represent on the map, which occur in the Beach light sandy loam. In such areas the gravel content is generally not so high as that of the main type and does not seriously interfere with cultivation.

Bad Lands.

The soil of the bad lands consist of silt and rocks. The rock is generally found at the tops of the buttes or around the edges of them where they have rolled down. Between the buttes are narrow, steep V-shaped valleys; on the slope of the buttes there is very little stone. The bad lands afford a good growth of grass except on the tops of the buttes, where it is stony. Such land can only be used for grazing purposes. The topography of the southeast quarter of township 139, range 105, is so largely composed of buttes that no survey was attempted. The celebrated Sentinel Buttes are found in the next township east.

SOIL SURVEY OF RICHLAND COUNTY, NORTH DAKOTA

By Frank Bennett, E. L. Worthen, Rex T. Willard and E. B. Watson.

DESCRIPTION OF AREA.

Richland County, N. Dak., is located in the extreme southeastern corner of the State. It is bounded on the north by Cass County, on the west by Ransom and Sargent counties, on the south by South Dakota, and on the east by Minnesota. The greater portion of the county lies north of the forty-sixth parallel north latitude, and east of the forty-eighth meridian west longitude, and has an area of 929,920 acres, or 1,453 square miles.

There are three distinct topographic divisions in Richland County. One consists of the country formed by the deposition of glacial till in the form of moraines, another is the region occupied by lacustrine deposits of Lake Agassiz, and the third is the territory comprising the delta deposits of the Sheyenne River in the old lake bed. The country formed by the glacial till in the southwestern part of the county is rolling to roughly hilly, with intervening sloughs and depressions. Characteristic bowlders and gravel are found scattered over the surface. The lacustrine deposits occupy the eastern portion of the area and are level to undulating, while that formed by the delta is rolling to hilly.

The Sheyenne, Red and Wild Rice rivers are the most important streams of the area. The Sheyenne river enters the northwestern corner of the county near Power and flows in a northeasterly direction, leaving the county near the center of the northern boundary line. Short and deep tributaries have cut back from the river and drain the county for a few miles on each side. The Red River, with its tributary, the Bois de Sioux, forming the eastern boundary line of the county, drains a portion of the area. There are a few small coulees (a) tributary to this stream. The Wild Rice River enters the county in Wyndmere Township, about 3½ miles south of the North-

a The word "coulée" is used in the local sense.

ern Pacific Railway, and flows in a southeasterly direction toward Great Bend, where it turns and flows northward. From a point 5 miles west of Wahpeton its course is almost parallel to that of the Red River for a distance of about 25 miles to the northern boundary of the county. A few coulees are tributary to the Wild Rice River, the largest being Antelope Creek.

The population of the county is 19,379. It includes many Germans, Norwegians, and Swedes. In the vicinity of Great Bend, and in the northeastern portion of the county, many prosperous farmers are found. At the time this section was opened for settlement many settlers came from Iowa and other older states. The eastern and southern portions of the county are the most thickly populated, the western portion being quite sparsely settled. A few quarter sections among the sand dunes are still open for entry. When the western and northwestern portions have a proper drainage system there should be an influx of population, as much of the now uncultivated land is capable of producing good crops.

Wahpeton, the county seat and largest town of the county, has a population of about 3,000. Hankinson and Lidgerwood located in the southern part of the county, are next in population, while Abercrombie, Fairmount, and Wyndmere are the more prosperous of the smaller towns.

The county is crossed by several railways, which furnish good transportation facilities. One of the main lines of the Great Northern from St. Paul to the West passes through Wahpeton, and thence northwest. The main line of the Minneapolis, St. Paul and Sault Ste. Marie enters the county at Fairmount and passes through Hankinson and Wyndmere northwest into Ransom County. A branch of the Great Northern from Tintah Junction, Minn., to Aberdeen, S. Dak., crosses the southern portion of the county near Fairmount and passes through Hankinson and Lidgerwood. The branch of the Chicago, Milwaukee and St. Paul Railway from Ortonville, Minn., to Fargo, N. Dak., crosses the eastern part of the county. Fairmount, Wahpeton, and Abercrombie are the principal towns located on this line. A branch of the Northern Pacific crosses the county, Wahpeton, Mooreton, and Wyndmere being the chief towns on the line. Besides these lines the Fargo and Southwestern, a branch of the Northern Pacific, passes just outside the northwestern border of the county, affording shipping points for farmers in this section.

The principal grain markets for the county are Minneapolis and Duluth, and frequent elevator stations are found on all the railroads. Each of the above-named towns in the area have three or

more grain elevators, which are usually owned by the larger elevator companies. However, there are a few elevators owned by a company of farmers. Live stock is shipped to South St. Paul or Chicago.

The condition of the county roads varies according to the soil type over which they pass. Those along the Red River over the Fargo loam, Fargo clay loam, and Fargo clay are hard and smooth when dry, but when wet they are frequently almost impassable. In the spring they are usually in the worst condition, but in the fall, when the produce is hauled to market, they are generally good.

CLIMATE.

The climate of Richland County is typical of the northwest, the winters being long and cold and the summers short and cool. The summer nights are short and generally cool and the twilights long. The last killing frost in spring is about May 8 and the first in the fall about September 15, giving a growing season of about four months. Lighter frosts frequently occur between these dates, and frosts have been known to occur every month in the year in this region. Short periods of extremely cold weather occur in winter, when the mercury stands at —40 degrees F., but as the atmosphere is dry the cold is not so severe as this low reading would indicate. The soil generally freezes in November to a depth of from 5 to 8 feet and remains frozen until spring, or about the 1st of April. From the 10th to the 20th of April plowing and cultivation are possible, even though the ground is frozen below.

Hailstorms occasionally damage the crops, but as these occur in small areas the damage is only local.

There are a few large windbreaks over the level prairie, but the northwest winds sometimes sweep across and do considerable damage.

The following table shows the normal monthly and annual temperture and precipitation, the absolute maximum and minimum temperatures, and the total precipitation for the wettest and driest years;

Normal monthly, seasonal and annual temperature and precipitation at Wahpeton.

Month.	Temperature.			Precipitation			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	15	54	−32	0.4	0.4	0.2	2.2
January	11	51	−30	.4	.4	.4	3.2
Febuary	11		−44	.6	Trace.	1.2	4.9
Winter	12			1.4	.8	1.8	10.8
March	26		−33	1.2	1.9	1.8	8.2
April	46		−2	2.5	3.4	5.1	1.1
May	58	98	−22	2.2	1.0	7.4	.0
Spring	43			5.9	6.3	14.3	9.3
June	67	101	27	3.4	2.6	5.8	.0
July	70	105	39	3.6	.2	4.8	.0
August	68	96	33	3.1	2.0	2.7	.0
Summer	68			10.1	4.8	13.3	.0
September	59	98	19	1.7	.8	2.7	.0
October	47	88	13	1.8	2.3	.5	1.8
November	27	72	−25	.4	.7	.8	2.7
Fall	44			3.9	3.8	4.0	4.5
Year	42	105	−44	21.3	15.7	33.4	24.1

AGRICULTURE.

It was in the vicinity of Fort Abercrombie, where the town of Abercrombie is now situated, that the fertility of the famous Red River Valley was first revealed to the pioneers who settled on the prairies at a time when the presence of United States soldiers was necessary for protection from the Sioux. However, it was not until about 1880, when the Great Northern Railway entered the county, that real agriculture was begun. The first settlements were made along the Red and Wild Rice Rivers. The timber along these streams was a protection in winter and was also convenient for building and for fuel.

Wheat and oats were the first crops grown, and later flax was found to give excellent results upon newly broken sod. This crop was grown very little in the early days owing to the low price, but in 1890 it became an important crop. At this time the price of flaxseed ranged from 60 to 85 cents a bushel. Since that time the price

has gradually increased, and it has been as high as $1.50 a bushel.

It was not until 1890 that barley came to be grown in considerable quantities. At the present time it is an important crop.

The broad prairies that surrounded the early settlers afforded large quantities of wild hay, and it was not until the country was well settled that it became necessary to grow the tame grasses. Timothy was found well adapted to the soil and has been quite extensively grown since the early nineties. In the last eight or ten years some clover has been grown, but it is not an important crop, as it does not withstand the severe winters.

Spelt has been grown to a considerable extent since the early nineties. It produces from 30 to 50 bushels per acre and occasionally more, and is chiefly used for feeding, being considered one of the surest crops for this purpose, as it never rusts and is not injured by frosts. Spelt is frequently mixed with oats and barley and ground for feed.

For the last eight or ten years several varieties of millet have been grown in small areas and are considered excellent crops for feeding purposes. Scarcely any of the crop is harvested for seed.

Corn has been grown for the last twelve years or more, the first good crop being grown about 1895. When first planted much difficulty was experienced in finding a variety that would mature before the early frosts. This has been overcome to a great extent by seed selection and acclimatization.

Wheat has always been the leading crop in the region. The next important crops are oats, barley, corn, and flax. The constant growing of wheat gradually decreased the yield from year to year until it was found necessary to introduce other crops for the purpose of rotation. The farmers have been forced to realize the importance of crop rotation and the successful farmers are at the present time growing a succession of crops.

In the early days the soil was so productive and gave such good yields of wheat year after year that the average settler considered it as inexhaustible. For this reason some land in the county has been so badly run down that only rotation and careful cultivation will ever bring it back to its former productiveness.

Upon the heavy, flat areas adjacent to the Red River considerable difficulty is experienced with the wheat crop during wet years, and for this reason it is often difficult for those who rent their farms to obtain desirable tenants. The land owners find that letting their farms out to tenants is often very unsatisfactory for the reason that the renter seldom takes the same interest in improving the soil and keeping up repairs as does the owner.

The following dates are about the average time of seeding: Wheat, April 1 to 10; barley, April 20 to May 10, sometimes a little later; flax, May 15 to June 10; corn, May 8 to 20. It is considered that the latter part of August is the best time for sowing rye, although some of it is just sown before the ground freezes. Barley is the first crop to be harvested, which is generally the latter part of July. Wheat and oats are usually harvested in the early part of September.

Practically all of the wheat grown in the region is spring wheat, the winters being too severe for winter wheat.

The Twelfth Census returned the acreage of wheat in 1899 as 317,746 acres. According to the county records the production of wheat has ranged from less than 2,000,000 to more than 4,000,000 bushels annually for the last five years, although within the last three years there has been considerable decrease in the acreage. The rotation of crops has been one of the causes for this decrease. The census gives the acreage of oats in 1899 as 57,016 acres. Since that time there has been a considerable increase. The production in recent years has ranged from 1,000,000 to 2,250,000 bushels. The acreage in corn in 1899 was 10,110 and in barley 8,937 acres. The production of flax in recent years has ranged from 21,000 to 30,000 bushels annually. The census returned the acreage in 1899 as 39,564. All of the wheat and flax is shipped to eastern markets, except a small amount of wheat which is consumed by the local mills. Practically all the hay and corn and a considerable amount of the barley and oats are used for feeding purposes.

The grain is threshed as soon after harvest as possible. Some of the grain is stacked, but a large proportion is handled from the shock. In the latter case more men are required and the cost of threshing is therefore considerably higher. There are two advantages in having the grain stacked for threshing—the cost is considerably less and there is less loss of grain. Where the entire crew is furnished by a thresher the following prices are about the average: Four to 5 cents per bushel for oats, barley, and spelt; 8 to 10 cents for wheat; 16 to 20 cents for flax. Where all af the crew and teams are furnished by the farmer the prices are appproximately as follows: Two to 3 cents per bushel for oats, barley, and spelt; 5 to 6 cents for wheat; 8 to 10 cents for flax.

Twenty-five to 30 horsepower traction engines are generally used with a blow-stacker separator. Straw is usually the fuel used. Sometimes, however, portable gasoline engines are used in place of the traction engine. These have become more popular in the last few years.

Several of the more wealthy farmers own threshing outfits, and do their own threshing as well as that of some of their neighbors. The plan of exchanging work, one farmer with another, is now practiced in some parts of the county. In this way considerable expense is eliminated.

Up to a few years ago stockraising was not common in the county, but since the yields of wheat have begun to decline this industry is becoming more important as an adjunct to general farming. Many of the more progressive farmers are now devoting about one-fourth of their farms to pasture or the production of hay. Sometimes, however, feed, such as corn or millet, is raised in place of pasturing the land. This is one step in the system of rotation. Cattle, horses and hogs are beginning to be raised to a considerable extent. A very few sheep are also raised. In 1907 county records show that there were about 21,000 head of cattle of all ages in the county, an increase of about 100 per cent in the last nine years. In the same year there were about 14,000 horses, about 7,000 hogs, and 2,000 sheep. The raising of sheep is declining, while the number of all other stock is increasing from year to year. The value of live stock is about $750,000.

Dairying is becoming an important industry. At the present time there are over 10,000 milch cows in the county. There are five creameries in active operation. Most farmers who are carrying on the dairy business have cream separators on the farms. Many make the cream into butter, while others ship it to St. Paul.

It is believed that great advantage will result from stock raising, for with only a small number of stock on the farms there is a sure income every year; whereas with grain growing alone there is an occasional year of failure. The straw that is now almost all burned should be used as feed or bedding for the stock, and thus converted into manure. If it is seen that the corn will not mature, it can be made use of for feeding purposes. On nearly every farm, particularly in the western part of the county, there is a considerable acreage of land that is uncultivable, owing either to lack of drainage or to the sandy nature of the soil, or to the roughness of the surface. Practically all of this unused land supports a good growth of grass, which should afford pasturage five or six months of the year. Much of the uncultivated land of the western part of the county is now pastured, but there are still many square miles which are not bringing in any return, except the small amount of prairie hay that is cut from them.

The farm buildings of the county are generally fair. Large, well-constructed barns frequently appear. It is noticeable, however, that

little care is given to housing the farm machinery, only a comparatively few of the farmers having sufficient shelter for the purpose.

In the northwestern part of the county there are a few cattle ranches. Some horses and a few sheep are also kept. There is considerable wild hay in this section of the county, but it is practically all consummed upon the ranches.

The United States census of 1900 gives the average size of farms in Richland County at 318.7 acres. It is probably smaller at the present time, as the large farms are gradually being cut up into smaller ones. The total acreage in farms in 1900 was 719,051; the value of farm lands and improvements, except buildings, was $11,399,940.

The greater part of the farm work, even in harvest time, is done by the farmer and his family. About 71 per cent of the farms are operated by the owners, the remainder being rented on the share or cash system. In case the renter furnishes the seed and pays the threshing bill he receives three-fourths of the crop. Where the owner furnishes the seed and pays half the threshing bill, the crop is divided equally. In recent years some of the more prosperous farmers have moved into town, generally leaving the farms in the care of tenants.

The development of Richland County has been rapid, and its present prosperous condition has been reached in about twenty-five years. In the early eighties the best land in Richland County could be bought for $5 to $8 an acre, while at the present time the price of the same land ranges from $25 to $50. Thus much of the present wealth of the county is the result of the advances in the prices of the land, and at the present valuation the farmer will have to practice more intensive methods in order to realize a good percentage of profit on his investment. The rotation of crops and careful cultivation cannot be too highly recommended. The fact that flax can not be grown on the same soil year after year demonstrates to the farmer that rotation is a necessity in order to get the best returns. The great variety of soils in the county present opportunities for many lines of farming, and it is not necessary to depend upon wheat as the money crop.

The most important problem in the county in connection with a diversified system of farming is to maintain permanently on the farms a number of live stock. Feed can be produced at a moderate cost from such crops as are necessary in a systematic rotation. A combination of timothy, clover, and brome-grass continues to give a good crop the fourth and fifth years. After these crops wheat will produce from 6 to 12 bushels more per acre.

Summer fallowing is quite general throughout the county and is becoming more so, especially upon the heavier soils. Plowing generally begins as soon as the grain is cut, and as much of the stubble as possible is turned under before the ground freezes. Some of the farmers burn the stubble, but as many of the fields need organic matter it is much better to plow the stubble under. Where the soil is very sandy it is not considered best to summer-fallow it, because of the tendency of the soil to drift.

Most of the plowing is done by gang plows drawn by four or more horses. Some of the plowing, however, is done with traction engines, which turn from eight to ten furrows at a time. After plowing the land it is left until spring. If the farmers are rushed with work in the spring they sometimes dispense with plowing, and where the grain is to be sown upon sandy soil they merely disk the ground and drill the grain into the old stubble. The corn crop is generally planted in check rows and is cultivated with sulky cultivators. The cultivation is usually insufficient, and sometimes the ground between the rows is allowed to become filled with wild oats and other weeds and grasses. More thorough cultivation would materially improve the corn crop and at the same time keep down the weeds.

The extermination of wild oats and quack grass is one of the serious problems confronting every farmer. It is believed, however, that by crop rotation, and by thorough, clean cultivation in the case of cultivated crops like corn, much can be done to control these pests.

Potaotes are not grown except for home consumption. The lighter soils of the western part of the county are well adaptted to them. This would be a profitable crop to include in rotation with grains. The yield ranges from 200 to 300 bushels per acre.

There are a few small patches of alfalfa in the county. Very little interest has as yet been taken in this crop, but it is believed that when properly handled it will do well.

As already noted, the farmers and their families do most of the farm work. Some labor is hired by the month, however, the usual wage being from $25 to $35 a month for a period of seven months.

A little labor is hired by the year, and when such is the case the price per month is somewhat less than when hired for shorter periods. During harvest time a good deal of day labor is required, the wages ranging from $2.25 to $2.75 a day. At this season of the year much of the labor is supplied by transients who come from eastern sections to take advantage of the high wages. According

to the Twelfth Census the farmers expended in 1899 $705,520 for labor.

Apples are being tried to some extent in this section, and it is hoped that in time a variety will be developed which will withstand the severe winters and mature its fruit during the short growing season. It is believed that the higher elevations in the western part of the county will be better adapted to fruit than the region of heavier soils adjacent to the Red River.

As a protection against the severe winds during the winter, nearly every farmer sets out a grove of trees on the north side of his house and farm buildings. Such rapid growing trees as the box elder, cottonwood, elm, and willow, are used for this purpose.

There are two sources of water supply in Richland County—surface wells and artesian wells. The former furnish a sufficient supply of water except in very dry seasons. An artesian supply may be found at depths ranging from 150 to 300 feet in most of the county, excepting the northwestern portion.

Much interest is being taken at present in the question of drainage. Open ditches are now being constructed by the county and in the northwestern section the drainage of large areas, heretofore used only for grazing, is being undertaken. Each landowner is taxed according to the benefit he will receive. In these poorly drained areas some alkali is found, but it is believed that this will be removed when drainage is established.

SOILS.

The soils of Richland county fall naturally into three groups, namely, those of glacial origin, those of delta origin, and those of lacustrine origin.

The soils of glacial origin are confined to the southwestern corner of the county and include practically all of the county west of Hankinson and south of the Wild Rice River. This portion of the county was once covered by an extension of the ice sheet known as the Dakota glacier. As the ice sheet moved slowly southward it ground up the rocks, granite gneiss, schist, limestone, shale, etc., over which it passed. This ground-up material was left as a veneer over the region upon the recession of the ice sheet. The surface features of this portion of the county are typical of a glaciated area, being made up mainly of low, rolling prairie with a succession of morainic hills, between which are often found kettle-like depressions. Through this portion of the county passes a chain of small, shallow lakes which extend from 6 miles northwest of Lidgerwood to Hankinson and southward. These lakes represent depressions in the

glacial channel of the Sheyenne River. The soils in the southwestern portion of the county are derived mainly from the weathering of the unassorted glacial material, and the principal types represented are Fargo loam, Marshall loam, Fargo sandy loam, and Marshall gravelly sandy loam.

The remaining portion of the county was formerly covered by a great lake, known to geologists as "Glacial Lake Agassiz." At that time the whole of what is now the Red River Valley, including Lake Winnipeg, was one continuous sheet of water. The surface of the region formerly covered by the lake is so level that in traveling over it one is reminded of being at sea, the plain being visible for only a few miles ahead. The tops of buildings and grain stacks are seen first, after which they gradually come into full view. This levelness is well shown by the fact that at Wyndmere the altitude is 1,065 feet, while at Wahpeton, 28 miles directly eastward, the altitude is 960 feet. In a north and south direction the fall per mile is even less, the average being less than 2 feet.

At the close of the Glacial period the melting ice swelled the streams to many times their present volumes, and large quantities of sand, silt, and clay were carried along by the streams and spread out over the bottom of the lake. The Sheyenne River at that time emptied into Lake Agassiz at a point near the present site of Hankinson, and that portion of the ancient lake bottom covered by the sediments brought down by the river is known as the "Sheyenne Delta." The eastern boundary of the delta in Richland County is appproximately a line connecting Colfax, Galchutt, Fairview Junction, Great Bend, and Oswald. All of the county west of this line, and not included in the glaciated area, belongs to the Sheyenne Delta. As would be expected, the soils derived from delta deposits predominate in sands. At the first checking of the river's current the coarser materials, like gravel and sand were deposited, while the finer sands and silt were carried farther into the lake. The gravels and sands were often reworked by the waves and piled up into beach lines, and this accounts for some of the small gravel areas in the western part of the county. The following are the main soil types derived from the deposits of Sheyenne Delta: Fargo fine sandy loam, Fargo fine sand, and Fargo sandy loam.

The soils of lacustrine origin are confined mainly to that portion of the area between the eastern boundary of the Sheyenne Delta and the Red River. The materials from which these soils are derived represent the depositions which took place in the middle of the old lake beyond the influence of inflowing glacial streams. In these deep, quiet waters only the finer materials, like clay and silt, were

carried in suspension. The region as a whole is flat and poorly drained and the soils are heavy. The following are the main soil types of lacustrine origin: Fargo clay loam, Fargo loam, and Fargo clay.

Besides the above classes of soils, there are several small areas where the sandy material of the Sheyenne Delta has been blown about and formed into dunes.

Associated with all the soil types in the county there are sometimes small, swampy, poorly drained depressions, and these were mapped as Meadow.

The following table gives the names and areas of the various types of soil. The accompanying map distinguishes the soils by means of colors.

Areas of Different Soils.

Soil	Acres.	Per cent.	Soil.	Acres.	Per cent.
Fargo fine sandy loam.	218,112	23.5	Fargo clay.....	11,136	1.2
Fargo loam.....	204,800	22.0	Lidgerwood fine sandy loam.	10,048	1.1
Fargo fine sand.....	144,256	15.5	Marshall gravely sandy loam.....	10,048	1.1
Fargo clay loam.....	113,280	12.2	Wabash loam.....	4,544	0.5
Marshall loam	91,264	9.8	Fargo gravely loam.....	3,840	0.4
Fargo sandy loam.....	53,504	5.7	Walcott sandy loam.....	3,264	0.4
Meadow	28,672	3.1			
Dunesand.....	19,008	2.0	Total.....	929,920	.....
Fargo silt loam	14,144	1.5			

FARGO CLAY.

The Fargo clay to a depth of 15 inches is a very heavy, tenacious, black clay. The subsoil is practically the same as the soil, although it is a little heavier in texture and lighter in color, being blue or mottled. When wet the soil is very gummy and sticky and frequently clogs the wagon wheels. It is locally known as "gumbo," and is the heaviest soil found in the area. Pockets of gypsum are frequently encountered in the subsoil and decomposed limestone nodules forming gray or white spots are sometimes found.

Practically all of the type is covered by a growth of wild grass and very little of it is cultivated. Occasional barren spots occur, which are due to the presence of alkali, but they are not of sufficient size to be of importance. It is the most difficult soil in the area to cultivate. When broken it forms very large clods which bake hard, and considerable harrowing is necessary to put it in fair

condition. The mechanical condition is much improved by the application of straw and coarse manures. In dry seasons large cracks occur in the soil, which often extend to a depth of several feet.

The Fargo clay has a level to flat topography. It occurs in slight basins in the eastern part of the county, and occupies but a small percentage of its area. The largest body is found west of Woodhall, and is about 4 miles long and 1½ miles wide. The only cultivated areas occur south of Christine and along the northern border of the county.

Nearly all the areas of this soil are poorly drained, which accounts for the fact that little of it is under cultivation. In many places attempts have been made to drain the land, but with little success, except in the northern part of the county, which has been well drained by open ditches and is producing good crops. In many places the expense of draining the small areas is so great that reclamation is not practicable.

The soil is derived from reworked glacial debris and consists of the finest part of that material which was deposited in the center of the old bed of Lake Agassiz.

The Fargo clay is most commonly used for the growing of wild hay, although frequently the grass is not of good quality. A great accumulation of organic matter makes the soil very fertile. As so little of the type is cultivated it is impossible to give accurate crop yields.

WABASH LOAM.

The Wabash loam to a depth of about 18 inches is generally a dark-brown or black loam, which contains considerable organic matter. The subsoil is lighter in color and slightly heavier in texture than the soil; otherwise it is about the same. The soil presents some variation, however, in that it has a sandy loam and clay loam phase, but these occur in areas too small to be indicated. Stones and gravel are absent from both soil and subsoil.

The soil is found in a continuous strip bordering on both sides of the Sheyenne River for a distance of 8 or 9 miles. It is about one-half mile wide and extends from the west county line to Barrie. It is also found in the oxbows of the Red and Wild Rice rivers and to a small extent along Antelope Creek. The areas occurring along the Red and Wild Rice rivers are very small and generally contain considerable very fine sand.

The topography of the soil along the Sheyenne River is undulating, while along the Wild Rice and Red rivers and Antelope Creek

it is practically level. The drainage is generally good, with the exception of the clay loam phase along the Sheyenne River.

The soil is of alluvial origin, being deposits of the streams along which it occurs. A sandy loam phase is found, where the soil is modified by material blown from adjoining sand areas.

Except the clay loam phase, which is sometimes too wet, the Wabash loam is easily cultivated, and is, in general, farmed. The uncultivated portion, occurring along the Sheyenne and Red rivers, is covered with a growth of timber consisting mainly of oak, ash, elm, and box elder.

The soil is adapted to the production of oats, wheat, barley, and corn. Wheat yields from 12 to 25 bushels per acre, varying according to the phase on which grown, and oats from 25 to 50 bushels per acre. Corn produces good yields, but along the Sheyenne River there is danger of it not maturing on account of early frosts. On the Wild Rice and Red rivers truck products are grown in gardens, where, owing to the light texture of the soil, it warms up early in the spring. The chief truck products are onions, radishes, potatoes, lettuce, beets, and cabbage. Potatoes are grown quite extensively and yield from 200 to 300 bushels per acre. The loamy phase is the most productive of the type.

The following table gives the results of mechanical analysis of the soil and subsoil of the Wabash loam:

Mechanical Analyses of Wabash Loam.

Number.	Description.	Fine gravel	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19595.....	Soil	0.0	8.8	3.5	23.1	9.8	38.6	16.3
19596.....	Subsoil	.0	3.7	2.4	17.8	10.6	39.6	25.7

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19596. 3.49 per cent.

FARGO FINE SAND.

The Fargo fine sand consists of 10 to 12 inches of grayish-brown fine sand, underlain by a subsoil of lighter colored fine sand. The areas are composed of a succession of rounded mounds with broad, shallow intervening depressions. The soil in these depressions is slightly heavier and deeper and contains more organic matter, which gives it a darker color. The knolls are from 5 to 15 feet high and vary in width from one-fourth acre to several acres in extent. The type sometimes occurs on slight ridges, evidently beach formations, which give it a gently rolling topography.

Owing to the peculiar topograpy the drainage is not generally good. The tops of the knolls are usually very dry, while the depressions are wet, some of them containing water the year around. Several short, deep channels cut through the sand dunes along the Sheyenne River and drain a portion of the soil. The drainage of the beach ridges is good. These occur in the vicinity west of Colfax, in the northwest corner of the county, and in the neighborhood of Hankinson.

About one-half of the area of Fargo fine sand is in a poorly drained condition, and such areas have been shown in the soil map by means of symbols. As would be expected, there is considerable variation in the soil of the swampy areas, especially as regards the organic-matter content.

The county is attempting to improve this soil by means of artificial drainage, and great interest is manifested in the question of its fertility and adaptability after being satisfactorily drained. In dry seasons, such as that of 1908, little drainage is necessary, except in the very lowest areas, but in ordinary or very wet years much of this type is under water, and for the last several years it would have been impossible to map the soil, as it was covered with water. None of the poorly drained areas are at present under cultivation.

The soil occupies the greater portion of the northwestern part of the county. The more swampy areas are found in Garborg, Homestead, Freeman, Sheyenne, and Viking townships. Two large areas in which the drainage is better occur—one north and the other south of the Sheyenne River. An area from 12 to 14 miles in length is found west of the Great Northern Railway near Walcott and Colfax, varying from about one-fourth mile to 3 miles in width. The other large area occurs west of Hankinson, where it is intermixed with several other types of soil. In the northwest corner of the county the type generally surrounds the sand dunes, and an area of considerable extent, surrounding sand dunes, occurs west of Homestead. Several small areas are scattered over the northwestern and south-central portion of the county.

The Fargo fine sand is a delta formation, and it has been reworked to some extent by the winds, which accounts for the presence of many low knolls. The sand extends to a depth of more than 3 feet, except in a small area bordering the Sheyenne channel. The entire delta, and hence the Fargo fine sand, is underlain at from 4 feet to unknown depths by a stratum of clayey silt. South of the Sheyenne River in the cuts of the short channels the silty material outcrops. Here, though the land is broken, good crops are grown, owing to

the fact that this heavier stratum is near the surface. In the northwestern part of the county the silt is covered by a shallower deposit of the sand than elsewhere.

The native vegetation consists of a good growth of prairie grass, with occasional areas of scrubby timber or bushes. Russian thistle appears in great quantities along the roads upon soil which has been broken and allowed to revert to sod. A large proportion of the type is used for pasture. Good prairie hay is cut in the wetter areas and, when the season is favorable, on some of the higher land. The greater portion of the soil is uncultivated, but a considerable area along the Sheyenne River and north of it produce good crops. Here the characteristic knolls are less numerous and the surface is more level. Generally when recently plowed the soil is shifted by the wind, and on this account the sod or stubble is seldom broken until spring.

The Fargo fine sand yields from 8 to 12 bushels of Bluestem or Fife wheat, but it is better adapted to the macaroni or durum varieties. Oats and corn produce fair yields, but not as good as on many of the other soils of the area. Owing to the lack of organic matter in the soil crop rotation is very essential.

The following table gives the average results of mechanical analysis of the soil and subsoil of this type:

Mechanical Analyses of Fargo Fine Sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*
19567,19597	Soil	0.1	0.5	1.4	62.3	25.2	7.1	3.2
9568,19598	Subsoil.....	.1	.3	1.3	67.4	20.7	3.9	6.0

DUNESAND.

Dunesand to a depth of 6 inches consists of a fine gray sand underlain by a yellow sand of practically the same texture. The only difference between the soil and subsoil is the presence of slight quantities of organic matter in the former which gives it a darker color and a somewhat loamy texture. In barren areas the soil and subsoil are identical, both being a yellowish fine sand.

Most of the Dunesand occurs in three comparatively large areas. The largest of these borders the Sheyenne River in the northwest corner of the county, the next largest is found northwest of Hankinson, and the third occurs near the county line west of Homestead. Smaller areas are scattered throughout the Fargo fine sand.

The surface of the soil is rough and broken, and composed of knolls and hills which rise abruptly from 25 to 125 feet above the surrounding prairie. The soil in the intervening depressions generally bears a fair growth of grass, and is more fertile than that on top of the knolls, which is frequently barren and constantly being moved by the wind. In the deeper depressions and along some of the slopes a stunted growth of scrub oak and choke cherry appears. There is an excess of drainage from the hills to the intervening depressions, which contain water in wet seasons.

Dunesand is a delta deposit which has been reworked by the winds, and probably varies in depth from a few feet to over 150 feet.

The type is uncultivated and has scarcely any agricultural value. It is held at $5 to $10 an acre for pasturage, but if pastured too closely it soon becomes barren, and is then drifted by the wind. The greater portion of this soil used for grazing purposes occurs in the northwestern part of the county.

FARGO CLAY LOAM.

The soil of the Fargo clay loam to a depth of 12 inches consists of a black clay loam containing a high percentage of organic matter. Below this to a depth of 18 inches the soil is a lighter colored clay loam, and frequently a clay. The vegetable matter content decreases with depth, and consequently the subsoil to a depth of 18 to 36 inches is a lighter color than the soil. The typical material is a dark-yellow stiff, silty clay or yellow clay, sometimes containing decomposed lime nodules, which form white spots, and pockets of gypsum crystals.

Some gravel is occasionally found in both soil and subsoil, but this is not characteristic of the type. The largest quantity was found in an area about 8 miles long, extending north and south, the greater portion being north of Wahpeton. This was practically the only area where gravel was noticeable to any extent, and here it occurred mostly in the subsoil.

The soil is very uniform and only slight variations can be detected, even in widely separated areas. Sometimes the gradation zone between this and other types is rather broad. The type is generally bordered by the Fargo loam, and in many places along this boundary both soil and subsoil are a little lighter in texture. There are occasional spots where the subsoil approaches a heavy silt loam, this being most noticeable southwest of Abercrombie.

Another slight departure from the type was encountered in small areas in depressions. Here the soil is a little heavier and frequently

extends to a depth of 24 inches with very little change in texture or color. The subsoil from 24 to 36 inches is much darker than that of the true type, being a very dark yellow or drab color, while the texture is a stiff clay. The areas covered by this phase are generally small and of comparatively little importance.

The Fargo clay loam is sticky when wet, and appears to be quite difficult to cultivate. When plowed it breaks into large clods. However, after these have been subjected to the weather and are dry they crumble beneath the harrow and form a good seed bed. Even if the soil is plowed when slightly wet there is not much difficulty in getting it in a good mechanical condition. During the summer, when the soil is comparatively dry, the first 4 or 5 inches is very looose and may be very easily dug up by hand. Below this the soil is moist and sticky.

The Fargo clay loam and Fargo loam are closely related. The surface soil of the former is generally a clay loam, though in some cases the first 4 inches may be a loam, and where the loam exceeds 4 or 5 inches in depth it is mapped as Fargo loam.

Practically all the Fargo clay loam occurs in the eastern part of the county. About four-fifths of the type is found in one rather broad, uniform area parallel to the Red River, which flows almost due north. The area extends from the northern boundary of the county, at which point it is about 7 miles wide, southward to a point 7 miles south of Wahpeton. It is broken but once by an area of Fargo loam about 2 miles wide, although there are some included areas of Fargo clay and Fargo loam. The next largest area is found west of Tyler. The remainder of the soil is in comparatively small spots.

The soil is drained by the Red and Wild Rice rivers. Most of it occurs as a broad, slightly depressed basin, which reaches its greatest elevation along or near the streams, the height gradually diminishing as distance from them increases. The soil has the poorest drainage of any of those used for farming. During an average season it has sufficient drainage, with the exception of an occasional depression, but in seasons of excessive rainfall crops are sometimes damaged. In some places ditches are utilized to carry off the surplus water.

The Fargo clay loam is one of the most productive soils in the county and has contributed much to the fame of the Red River Valley as a wheat-growing section. It retains moisture well and during droughts crops frequently flourish while those on the lighter soils suffer badly for the lack of moisture. It is particularly well adapted to wheat, oats, barley, and flax. Corn grows well, but its chances

for maturing are not as good as upon some of the lighter and better drained soils. Wheat ordinarily yields from 12 to 25 bushels per acre, and where crop rotation is practiced the yields in good seasons reach 35 bushels. Corn yields from 35 to 50 bushels per acre; oats from 35 to 60 bushels per acre, and flax from 7 to 12 bushels per acre. Where native grass apppears it is luxuriant.

The following table gives the results of mechanical analysis of fine-earth samples of the soil and subsoil of this type:

Mechanical Analyses of Fargo Clay Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*
19589.....	Soil	0.0	5.0	3.8	7.3	6.0	37.6	40.3
19590.....	Subsoil	.0	3.1	1.9	8.4	4.1	34.6	47.8

FARGO SANDY LOAM.

The surface soil of the Fargo sandy loam is a dark-brown to brown fine sandy loam to a depth of 18 inches. From 18 to 24 inches a yellowish sandy loam is found which contains more fine sand than the material above. Immediately below this to a depth of 36 inches is a grayish-yellow silt loam in which the finer grades of sand predominate. Gravel is often found in small quantities in both soil and subsoil, the proportion being greater in the subsoil. This was most noticeable along the Wild Rice River, where generally a narrow strip about one-fourth mile in width occurs on either side of the stream. From a depth of 12 to 20 inches the sand is somewhat coarser than in the surface soil.

The Fargo sandy loam is somewhat similar to the Fargo fine sandy loam, and the two are generally associated. The principal difference is that the Fargo sandy loam has a silty subsoil, while the Fargo fine sandy loam has a sandy loam subsoil. It was difficult from the surface to make a distinction between the two types, and in tracing the boundary lines it was necessary to make a large number of borings.

Owing to the sandy nature of the soil, it is very easy to cultivate. Only a few stones are found in the soil. The soil is generally very uniform, there being only one or two variations, the greatest of these occurring west and southwest of Barney, where the surface soil was quite heavy, approaching a loam. In this vicinity there is a stratum of 6 or 8 inches of very fine yellowish silty sand between the soil and the subsoil. Occasionally the silty material of the

subsoil is not encountered until a depth of 30 inches is reached, the soil being a sandy loam to this depth. Where the silt was barely reached at a depth of 3 feet the soil was classified as Fargo fine sandy loam.

The Fargo sandy loam is located chiefly in the southwestern part of the county, near the Wild Rice River, and extends from the county line, west of Wyndmere, to within a few miles north of Hankinson. The only other areas of importance are found south and west of Hankinson, for the most part near the old Sheyenne channel, which crosses this section of the county. The soil usually occurs in comparatively large areas, and there are only a few that cover less than half a section.

The topography is usually undulating, but on account of the short channels reaching back from that stream it is slightly broken along the Wild Rice River, which drains the greater part of the type. As the areas generally have an elevation of from 20 to 60 feet above the normal water level of the stream, the drainage is good. In the vicinity of Wyndmere, where it borders the Fargo fine sandy loam, the soil is nearly level and is not so well drained, but crops do not suffer except in very wet seasons.

The soil is derived from reworked glacial material, but the Wild Rice River in times of overflow has deposited the gravel and some coarse sand.

The soil appears to be free from alkali, but an abundance of lime is evidently present, as the gray silty material contains a large percentage of carbonate.

This soil is the most desirable sandy loam in the area for general farming. The silty subsoil holds water well, so that the type withstands drought very satisfactorily. Where the silty subsoil is within 12 to 20 inches of the surface the soil is more desirable than where found at a depth of 30 inches, as the crop yields are generally better. The soil is well adapted to all the crops generally grown in the county. There is a small area along the Wild Rice River which is not farmed, owing chiefly to the fact that it is cut by stream channels, and is, therefore, too rough for cultivation. Wheat yields from 15 to 25 bushels and oats from 25 to 40 bushels per acre. Barley yields from 20 to 40 bushels and flax from 8 to 15 bushels per acre. However, there is little of the latter grown at present. The soil ranks among the best in the county for the production of corn and durum wheat. It is not often that corn fails to mature on this type when an early variety is grown, and yields of from 35 to 60 bushels per acre are secured. The soil is also well adapted to potatoes and various other truck products.

The following analysis of the soil and subsoil show the composition of the fine earth of the Fargo sandy loam:

Mechanical Analyses of Fargo Sandy Loam.

Number.	Description.	Fine gravel.	Coarse. sand.	Medium sand.	Fine Sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19551.....	Soil	0.0	0.4	0.4	16.1	38.6	39.9	3.9
19552.....	Subsoil	.0	.4	.4	4 9	28.7	57.1	8.2

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19552, 9.05 per cent.

MARSHALL GRAVELLY SANDY LOAM.

In general the Marshall gravelly sandy loam to a depth of 10 inches has a dark-gray color and is composed of a light loam or a heavy sandy loam which contains a relatively large proportion of coarse sand and fine gravel. The subsoil to a depth of from 10 to 36 inches consists of a sandy silty material containing some gravel, the content of which increases with depth. Sometimes the gravel and sand in the subsoil are irregularly stratified. Both soil and subsoil have a number of variations, but the material is so complex it is impossible to seprate them.

The topography is broken and hilly, being composed of marainic knolls and hills with intervening depressions or sometimes small valleys. On the tops of the knolls and hills the soil is generally loam, and it was frequently impossible to make a boring more than 12 inches deep, the subsoil in such places consisting of coarse and fine gravel and coarse sand. Along the slopes the soil becomes more loamy and the gravel content generally decreases toward the foot of the hills. In the intervening depressions the soil is usually black loam containing considerable quantities of organic matter to a depth of about 15 inches. Here the subsoil from 15 to 36 inches is a rather heavy, yellow silty clay. These phases occur only in spots of a few acres. In some of the depressions water is found until early summer. Glacial bowlders, consisting of granite, gneiss, schist and limestone, are frequently scattered over the surface, being most numerous in the vicinity of Elsie Lake. In some places where they occur in large numbers they are shown on the map by symbol.

Not over one-third of this type is under cultivation, the fields being located chiefly on some of the slopes and in a few depressions where the soil is better than the average. Where gravel and stones appear the soil is sometimes difficult to cultivate, but where these are not numerous very little trouble is experienced. Such areas,

however, are comparatively small. The hilly topography makes the use of improved machinery laborious.

The larger bodies of Marshall gravelly sandy loam occur southwest of Hankinson, where there are areas containing more than 2 square miles. Between Hankinson and Lidgerwood, south of the old channel of the Sheyenne River, there is a continuous strip bordering this channel. The next larger area is found west of Lidgerwood along the county line. Northwest of Lidgerwood on both sides of the old channel of the Sheyenne River are found many small ridges and knolls of this soil. The small ridge south of the Wild Rice River is part of an ancient beach formation.

Areas of this type lie at altitudes over 1,100 feet above sea level and the highest point in the county occurs on this type southwest of Hankinson, where the altitude is about 1,280 feet. On account of the gravelly and sandy nature of the soil and its rolling to hilly topography the natural drainage is excessive, except in the depressions. The drainage is chiefly into small lakes found throughout the areas; the greater proportion of the gravel and stones is found bordering these lakes.

The Marshall gravelly sandy loam consists of glacial deposits which are terminal and ground moraine. None of the type south of the Sheyenne River has been reworked by water, but the smaller areas north of the channel have the appearance of having been slightly altered by the action of water.

A slight trace of white alkali occurs in a few of the small depressions, and in some of the larger lakes the water contains considerable alkali. In no case, however, is the amount sufficient to be of any importance.

The native vegetation consists of prairie grass, and slough grass of poor quality for hay is found in the depressions. A few small oak, elm, and box-elder trees border some of the lakes. No accurate estimate can be made of the crop yields, as they vary on the different phases. Wheat, oats, and flax are grown and a few apple orchards are found. This type is probably better adapted to apple growing than any other in the area, especially in areas having a silty clayey subsoil.

The result of mechanical analyses of fine-earth samples of the soil and subsoil of the Marshall gravelly sandy loam are given in the following table:

Mechanical Analyses of Marshall Gravelly Sandy Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand,	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19569.....	Soil	10.4	20.4	9 4	14.0	10.8	28.8	6.
19570.....	Subsoil.....	9.9	14.3	4.1	8.2	7.8	40.1	15.9

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19570, 36.40 per cent.

FARGO FINE SANDY LOAM.

The surface soil of the Fargo fine sandy loam to a depth of six inches is a dark-brown fine sandy loam containing considerable organic matter. From a depth of 6 to 12 inches the soil has about the same texture, but is slightly lighter in color, indicating the presence of less organic matter. The subsoil to a depth of 18 inches is slightly heavier than the soil and is of a yellowish or grayish color, becoming slightly lighter in color at a depth of 30 inches, and at 36 inches contains considerable more fine sand. It is sometimes mottled with read and white and continues to a depth of at least 4 feet, as shown by cuts and ditches, where it is underlain by a silty clay of unknown depth. This latter material is usually a bluish drab color, mottled with white, evidently the result of decayed limestone nodules, and with red and black. This stratum of heavy subsoil underlies practically all of the Sheyenne Delta at varying depths, and comes to the surface in limited erosions south of the Sheyenne River. It appears nearer the surface in the heavy phase of the type and at the surface in the Fargo silt loam.

The Fargo fine sandy loam forms about 23 per cent of the area of the county, having an extent of about 341 square miles. It is the predominant type north of the center of the county, while large areas of it are found in the southeastern part. In the area north of the Sheyenne River the silty clay substratum lies from 4 to 10 feet below the surface. Between Wyndmere and the sand dunes along the Sheyenne River it is broken by areas of Fargo fine sand, too small to be shown on the map, and by other areas of the same type, which extend into this locality from the vicinity of McLeod, in Ransom County.

In the vicinity of Great Bend and also in the southern part of the county the Fargo fine sandy loam forms the better class of farming land, and in the former locality some of the most prosperous farms in the county are found. The small areas that occur interspersed in other soils are generally good land. In the southern part of the area

the sand dunes and Fargo fine sand border the Fargo fine sandy loam and are closely associated with it in origin and formation. Where the type borders the former it is somewhat sandier than the typical soil. On the other hand, where it borders heavier soils it has a slightly heavier texture. In both of these cases there is no distinct dividing line between the soils, and the soil conditions in the zone of gradation are frequently complpex.

An important instance in the modification in the Fargo fine sandy loam due to the influence of another type of soil is found in the southern part of the county, where it grades into the Fargo loam. Here there is a strip of country about one mile wide and five miles long, where the soil is slightly heavier and is considered a little more fertile than the typical soil.

The topography is undulating to slightly rolling and practically all areas have good drainage, except those lying next to the Fargo fine sand, where, in wet seasons, the drainage is inadequate. Antelope Creek is the only stream of any size flowing through the type, and bordering this creek the soil has its highest elevations. Some of the drainage passes through the Wild Rice River, but evidently a large part of the rainfall seeps into the soil and is carried off underground.

The Fargo fine sandy loam is found entirely within the area of the Sheyenne Delta and is derived from reworked glacial material brought to its present position by the Sheyenne River. It represents the finer deposits of the delta, along the western and southern edges of which it lies.

There are occasional slight indications of alkali in the soil, but the quantity is not sufficient materially to injure crops. The alkali is found chiefly in areas of deficient drainage.

The soil is easily cultivated and it is generally farmed, though there are a few areas left for hay, of which the yield and quality are good. There is no apparent reason why these areas should not be cultivated, if this were desirable. Wheat, oats, barley, and corn are the principal crops with some flax. Macaroni or durum wheat is much better adapted to the soil than the Fife or Bluestem varieties. The type is excellent for corn and some of the best crops in the area were seen growing on this soil. In some fields corn reached the height of ten feet. The earlier varieties mature in average season. Small grains yield nearly as well on the Fargo fine sandy loam as upon the Fargo clay loam, but the former is not as durable as the latter and crops should be rotated in order to maintain its productiveness. Various truck crops are also well adapted to this type.

Fargo fine sandy loam, heavy phase.—The surface soil of the Fargo fine sandy loam, heavy phase, consists of 8 to 12 inches of fine sandy loam which to a depth of about 10 inches contains considerable organic matter. From 10 to 20 inches the material is a yellowish fine sand and underlying this to a depth of 3 feet or more is a heavy, drab-colored clay or clay loam, usually mottled with white or grayish calcareous silty material due in part to decomposed limestone concretions. Where the silty material is absent the subsoil is usually a clay. Though somewhat heavier than the typical soil, this phase is friable and easily cultivated. It does not bake or puddle and the heavy subsoil, which retains water well, enables the crops to withstand drought.

Areas of this phase occur chiefly in the vicinity of Mooreton, in the central part of the county. The topography is generally level, and owing to the impervious nature of the subsoil there is very little seepage. A small coulee in the eastern part of the largest area carries off the greater part of the drainage water.

The soil occurs near the edge of the delta, and the subsoil is a heavy phase of the stratum of silt which underlies the greater part of the delta. In the low spots there is a slight indication of alkali in the soil, but not sufficient to be injurious to vegetation. The subsoil contains a considerable percentage of lime, derived largely from decayed limestone.

The greater proportion of the heavy phase of the Fargo fine sandy loam is under cultivation, and the crops are generally good. Occasionally there are small areas that are uncultivated. The soil is well adapted to grasses, such as timothy, brome grass and clover. Where native grass appears, it is of good quality and yields from one to two tons of hay per acre.

The following table gives the results of mechanical analyses of the soil and soubsoil of the two phases of the Fargo fine sandy loam:

Mechanical Analyses of Fargo Fine Sandy Loam.

Number.	Description.	Fine gravel	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19555.....	Soil	0.2	0.3	0.8	27.0	44.0	23.7	3.5
19556.....	Subsoil	.0	.1	.5	23.3	55.5	18.0	2.5
Heavy phase:								
19593	Soil	.0	2.4	.5	47.3	20.8	22.3	6.4
19594.....	Subsoil	.0	1.9	1.5	19.2	12.7	46.0	18.0

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19594, 13 08 per cent.

MARSHALL LOAM.

The soil of the Marshall loam to a depth of 14 inches is a brown to black loam containing a large proportion of silt and a considerable quantity of organic matter. At 10 to 14 inches below the surface it becomes somewhat heavier in texture and lighter in color. The subsoil from 14 to 36 inches is a yellowish-gray heavy silt loam or silty clay. Where the surface is rolling some gravel is usually found in the soil, and it is generally found in the subsoil. There is some variation in the texture of the subsoil. It is heavier in the more level areas, which are generally found near the boundary line between this and the Fargo loam. A few stones are scattered over the soil, and both gravel and stone are frequently found surrouding the small lakes and basins and where the type joins the Marshall gravelly sandy loam. This soil is a gradation between the Marshall gravelly sandy loam and the Fargo loam, but has the same origin as the Marshall gravelly sandy loam.

The type is confined to the southwestern corner of the county, and is found principally north and south of Lidgerwood, where it covers low, gravelly hills. Two phases occur, one north and the other south of the old channel of the Sheyenne river near Lidgerwood, that north being somewhat modified by the action of the water, and that south being typical drift. The area in the extreme southwest is pitted by many small basins and potholes, which range in extent from a few acres to more than a section. The small areas contain water a large part of the year and have been represented on the map as Meadow. This is the principal type in the southwestern portion of the county south of the ancient Sheyenne channel.

The topography is generally rolling and sometimes slightly hilly, the more rolling portion occurring south and west of Lidgerwood. The more level or gently rolling areas lie in the extreme southwestern corner of the county, near the county line south of Hankinson, and in that part north of the old glacial channel. The areas range in elevation from 1,090 to 1,250 feet above sea level.

The drainage is generally good, the type being one of the best drained in the area, though occasionally there are small depressions of a few acres each in which drainage is inadequate. Even here crops are damaged only in seasons of abnormal rainfall. Much of the rain water passes into the soil, and is removed by underdrainage. The surface run-off drains into the Wild Rice River.

The soil is glacial in origin and is derived mainly from morainal deposits, though in the more northern part of the area, which was near the shore line of glacial Lake Agassiz, the material has been subjected to some extent to the action of the water.

The greater portion of the type is under cultivation. Native grass grows well on the uncultivated areas, which generally occur near the small lakes or where the type is more rough or gravelly. The soil ranks in general with the best soils of the county for general agriculture, there scarcely ever being an entire crop failure. It is well adapted to wheat, oats, barley, and corn. Oats yield from 30 to 40 bushels per acre, and wheat from 21 to 25 bushels per acre. Corn generally matures on this soil.

The results of mechanical analysis of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical Analyses of Marshall Loam.

Number	Description	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Very fine sand	Silt	Clay
		Per Cent	*Per Cent*	*Per cent.*	*Per cent*	*Per cent*	*Per cent*	*Per Cent*
19573.....	Soil	1.1	6.1	3.0	14.0	7.5	50.6	17.7
19574.....	Subsoil.....	1.4	4.5	3.7	11.7	8.7	41.3	28.4

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19574, 13.55 per cent.

MEADOW.

The term "Meadow" is used to cover the low-lying areas which are too wet to produce crops. The texture of the soil varies from sandy loam to clay loam, but it is generally a black loam overlying a black loam or clay loam containing a high percentage of organic matter. Occasionally the percentage of organic matter is so high that the soil to a depth of 10 or 15 inches presents the characteristics of muck. Areas of this nature are found in the old channels of the Sheyenne River and in a few of the larger depressions elsewhere.

There are two distinct phases of Meadow as mappped in Richland County. That part of the soil along the bottom of the Wild Rice River and in the old channel of the Sheyenne River constitutes one phase, while the small areas on the rolling prairie in the southwestern part of the county chiefly make up the other. The area along the Wild Rice River is an alluvial deposit varying in width from about one-sixteenth to a little over one-half mile, and follows the river from the western county line for about 20 miles, covering practically the whole bottom of the channel. The other phase is lake deposit or material washed from the hillsides into the depressions. The character of the soil varies according to that surrounding the depressions. During a wet season water stands in these throughout the entire summer, and they nearly all contain water at some season of the year. Frequently in the old Sheyenne channel the subsoil contains a large

percentage of gray silty material, or it may be a gray, mottled impervious clay.

Meadow occurs generally in the southwestern part of the county, and a few scattering areas are found in the north and one larger area in the southeast. A comparatively large area of Meadow borders the Bois de Sioux and extends from about 1 mile north of Fairmount to the county line. The soil in this area is rather uniform in texture, being generally a clay loam underlain by a clay.

The phase occurring along the Wild Rice River would be well drained if it were not for the immpervious nature of the soil. There is no surface drainage over the remainder of the type. As the areas are usually small and scattered, the cost of draining them would be too great to make it practicable.

The topography is level or flat, the areas generally being surrounded by bluffs or hills. The areas along the Wild Rice River and the old Sheyenne channel are from 40 to 60 feet lower than the surrounding prairie.

None of the soil is under cultivation. It is covered with prairie and slough grasses, though often the latter is not of good quality. However, in some of the depressions good prairie hay is cut, the yields ranging from 1 to 2 1-2 tons per acre.

WALCOTT SANDY LOAM.

There is an area in the northern part of the county where the soil varied so much within short distances that it was impossible to show the distinctions on a map of the scale used in the present survey. The materials were consequently grouped together and given the name "Walcott sandy loam," as the dominant texture of the surface material is a sandy loam. The soil varies from a dark-brown loam to a gray sandy loam and the subsoil from a clay to a sand. The profile may consist of a sandy loam 8 to 10 inches deep, underlain by a yellow sandy clay, or by a yellow sand. Where the top soil consists of a loam the subsoil is generally a yellowish-drab clay, but it is frequently a yellow sand or sandy loam. Another phase composed of small sand mounds from 1 to 2 feet above the adjacent soil, is scattered through this type, and is practically the same as the Fargo fine sand. The sand extends to a depth of three or more feet and is sometimes drifted by the action of winds.

The topography of the Walcott sandy loam is level, with the exception of the small sand mounds or ridges already mentioned. A considerable part of the soil is poorly drained and uncultivated. It is in these areas of deficient drainage that the heavier phase is found. Excepting the sand mounds, which are always well drained, artifi-

cial drainage would benefit the whole type, especially during wet seasons.

The Walcott sandy loam is found in the northern part of the county near Walcott in a single area 5 miles long and 1 mile wide. It is the least extensive soil type in the county.

The soil is a mixture of Fargo fine sand, Dunesand and Fargo loam. Some portions of the soil possibly have the same origin as the Fargo loam, but it is difficult to explain the formation of the type as a whole. The sand content of the level areas and the sand found in the dunes may possibly have been drifted originally from the Fargo fine sand which lies just west of the type.

The crop yields vary with the character of the soil, and it is practically impossible to form an accurate estimate for the county as a whole. The undrained portions of the type are used for the production of prairie hay, and yields of 1 to 2 tons per acre are obtained. A considerable part of the uncultivated area is used for pasturage.

On account of the great variation in this soil no samples were collected for analysis.

FARGO SILT LOAM.

The soil of the Fargo silt loam is a brown silt loam 14 to 20 inches deep, with an average depth of 18 inches. The sand content is almost entirely of the fine and very fine grades and the content of organic matter is relatively large. The subsoil consists of a yellowish-gray or gray silt loam of practically the same texture as the soil. In some places the upper 4 inches of the soil are almost a fine sandy loam, and sometimes the subsoil consists of a drab or brown clay loam having a substratum of very fine, yellowish, sandy, silty material. This irregularity in the subsoil is found near the Fargo loam.

The Fargo silt loam as it occurs south of the Wild Rice River is frequently difficult to distinguish from the Fargo sandy loam, as the latter type in this vicinity contains considerable silt in the surface soil. When typically developed there are no stones or gravel in the soil or subsoil, though occasionally a small quantity of gravel is found in the latter. The area in the vicinity of Mantador and the one near the southern county line contain more fine sand than the area near the Wild Rice River on the western county line.

The soil is easily cultivated and can be put in a good state of productiveness without much difficulty. The small area near the jog in the western boundary line of the county, however, being lower and not well drained, is less valuable farming land.

The largest area of Fargo silt loam occurs in the western part of the county near the Wild Rice River. Two areas are located a few miles southwest of Mooreton and a small area is found in Freeman Township. Another small area occurs in the vicinity of Mantador, and a larger one is found near the county line in the southern part of the area.

The topography is generaly undulating, and the soil is well drained, except a small area near the county line west of Wyndmere. The Wild Rice River receives the greater part of the drainage from the type.

The soil occurs within the Sheyenne Delta, and is therefore derived from reworked glacial material brought into Lake Agassiz during its higher stage. It is in this type that the stratum of silty clay, already mentioned as underlying much of the delta, comes to the surface, and it is the principal factor in forming the soil.

The type is apparently free from alkali, but there is a considerable amount of lime in the subsoil.

Almost the entire area of the Fargo silt loam is under cultivation, and it is considered one of the best soils in the area. It is well adapted to timothy and other grasses, as well as to various small grains. Wheat yields from 15 to 30 bushels per acre, and macaroni wheat somewhat more. Oats yield from 25 to 50 bushels per acre. The native vegetation consists of prairie grass of good quality. The soil retains moisture well, and there is little evidence of any decline in its productiveness from year to year.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Fargo Silt Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19557.....	Soil	0.2	1.4	0.8	7.1	10.8	70.1	9.6
19548.....	Subsoil	.0	.4	.6	4.0	13.9	69.1	12.1

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19558, 10.45 per cent.

FARGO GRAVELLY LOAM.

The Fargo gravelly loam consists of 12 inches of a brownish loam underlain by a dark brown loam to a depth of 3 feet. A few glacial bowlders are scattered over the surface, and both soil and subsoil contain some gravel. The soil is closely related to the Marshall loam, which occurs immediately south of it. The chief difference

between the two types is found in the subsoil. The subsoil of the Marshall loam consists of a gray, silty, calcareous material, while that of the Fargo gravelly loam is a loam or a slightly sandy loam. This may be due to the fact that the type under discussion is located within the area of the delta, while the Marshall loam is found chiefly outside of the old lake bottom.

The Fargo gravelly loam is located in the western part of the county, south of the Wild Rice River. The largest areas are found from one to 3 miles from its channel, and a few small areas are located nearer the channel. The topography is undulating to gently rolling, with a slight slope toward the Wild Rice River. The natural drainage is good. There are a few short, deep channels that have cut back from the stream to the type, but the areas adjoining these are not under cultivation.

The soil is of delta and beach formation, and occurs near the edge of the delta deposits. A ridge passing through the main body of soil is a part of the Herman beach of Lake Agassiz.

The Fargo gravelly loam is generally easy to cultivate, though a portion of it has never been broken. Where not under cultivation the native prairie grass is good. There are no trees or shrubs occurring on the type. The principal crops now grown are wheat, oats, and corn, and the yields are about the same as on the Fargo fine sandy loam.

LIDGERWOOD FINE SANDY LOAM.

The soil of the Lidgerwood fine sandy loam generally consists of a brown or dark-brown fine sandy loam to a depth of 18 inches. Frequently the soil becomes slightly coarser in the lower depths. The subsoil is a light-brown medium sand frequently mottled with white and reddish material. The areas show some variation. In places the soil is a fine sand underlain by sand; in others a sandy loam underlain by sand or sandy loam. The lighter textured soil appears along the old channel of the Sheyenne River near Lidgerwood, where there is a slight ridge having some of the characteristics of a beach formation.

The soil is located in the southwestern portion of the county, bordering the old glacial channel of the Sheyenne River. It extends from the western county line in Dexter Township to a point about 4 miles east of Stiles, and occurs in the bottom of the channel and on the slopes and low hills bordering it.

In topography the Lidgerwood fine sandy loam varies from nearly level in the channel to rolling on the hills. A small proportion of the

soil in the bottom is poorly drained, but that found on the slopes and on the hills is well drained.

The soil is of alluvial origin, being the deposit of waters of the Sheyenne River during, or before, the earlier stages of Lake Agassiz. The fine sandy loam in the bottom is irregularly interspersed with areas of heavier deposits mapped as Meadow.

The type contains considerable organic matter and is very productive, especially in the hilly areas. It is easily cultivated, and the greater part is under cultivation. Some areas in the poorly drained bottoms support a good growth of grass, which makes hay of excellent quality. Along the roads and in a few abandoned plowed fields some Russian thistle, locally known as "tumble weed," was observed. The chief crops now grown are wheat, oats, barley, and corn. The yields of small grains are not as good as upon the Fargo fine sandy loam, but corn should do exceedingly well on this type. Potatoes and other truck crops are well adapted to this soil, though not extensively raised at present.

The following table gives the results of mechanical analysis of the soil and subsoil of this type:

Mechanical Analyses of Lidgerwood Fine Sandy Loam.

Number	Description	Fine Gravel	Coarse Sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
19579.	Soil	1.7	7.6	8.0	47.1	12.0	19.4	4.3
19580.	Subsoil	1.2	6.1	6.9	52.1	16.6	12.0	5.3

FARGO LOAM.

The Fargo loam to a depth of about 15 inches consists of a dark or almost black mellow loam in which the sand content is practically all of the fine and very fine grades. Below this to a depth of 20 inches is found a yellowish loam, sometimes heavier in texture than the surface soil, and this grades at a depth of 3 or more feet into a yellowish silty clay containing in the upper portion some fine sand, the content of which decreases as the depth increases. Occasionally both soil and subsoil contain a small percentage of gravel, this being most noticeable in the area bordering the Red River north of Wahpeton. At the northern end of this area a few small bowlders occur on the surface. In a few areas the quantity of gravel was sufficient to warrant the use of a symbol in the map. It occurs here and there in beds on slight ridges or knolls, and is most abundant in the subsoil. Occasionally small bowlders appear on the surface. Surrounding this

gravelly phase for some distance very little gravel is found in the soil, but it is reached in the subsoil at depths of 15 to 24 inches below the surface. Pockets of gypsum frequently occur in the subsoil, and partially decomposed limestone nodules are also encountered.

The Fargo loam is comparatively uniform. One of the most marked variations occurs along the contact with the Fargo sandy loam. In places there is a strip a half mile wide between the two types where the soil is not typical of either. Here the surface soil of the Fargo loam contains considerable more fine sand than the true type, and the subsoil is also lighter in texture, being in places a heavy silt loam containing a high percentage of fine sand and very fine sand. This phase is less productive than the remainder of the soil.

There is another phase which consists of the areas bordering the Red and Wild Rice Rivers, paralleling these streams and varying from one-quarter to 1 mile in width. Here the soil has at some time been affected to a certain extent by small alluvial deposits laid down by the streams. Along the Red River the influence of such deposits has been more marked than along the Wild Rice River. The soil generally occurs upon slight terraces, and as a rule is very mellow loam containing more fine and very fine sand than the typical soil. There is not much difference, however, in the subsoil, although it is a little lighter both in texture and color. The highest percentage of sand in these areas was found north of Abercrombie, though the type generally has its heaviest texture in the northern part of the county.

The greater proportion of the Fargo loam occurs in one very irregular continuous area extending from the center of the northern boundary of the county to the southeastern corner. It varies in width from one-fourth mile to 13 miles, gradually becoming wider toward the south until it reaches its maximum width about 3 miles south of Fairmount. In the vicinity of Mooreton, and a few miles south of Barney, irregular areas of the main body extend toward the west. There are areas in which artificial drainage would be beneficial, but the main body of the type is well drained. Small depressions only a few rods wide are sometimes quite numerous. These are generally round and from 2 to 4 feet below the level of the surrounding country. Water frequently stands in these depressions until early summer. The soil in them is very black and rich in organic matter, the first few inches sometimes having the characteristics of peat. Nearly all of these spots are found south of Wahpeton, very few being found in the northern part of the area. They were too small to be represented on the map.

The soil is easily cultivated. Both soil and subsoil are sufficiently heavy to hold a relatively large quantity of moisture and to retain it in time of drought. When the soil is broken up clods are formed, but these do not bake hard, and a good seed bed is easily prepared by light harrowing. The percentage of organic matter in this soil is generally less than that in the Fargo clay loam. It is probably not as strong a soil as the latter, but it is for the most part better drained.

The following table gives the results of mechanical analysis of a fine-earth sample of the soil and subsoil of the Fargo loam:

Mechanical Analyses of Fargo Loam.

Number	Description	Fine gravel	Coarse Sand	Medium sand	Fine Sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
19587.....	Soil	0.1	3.2	0.3	18.1	27.3	36.5	14.2
19588.....	Subsoil	.0	.4	.4	5.5	11.9	49.5	32.2

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$); No. 19588, 6.15 per cent.

SUMMARY.

Richland County, N. Dak., area 1,453 square miles, is situated in the southeastern corner of the State. The eastern third of the county is flat or level. The remainder is quite rolling and in the western part some of the surface is rough. The county is drained by the Sheyenne, Red, Wild Rice, and Bois de Sioux rivers. These streams have few tributaries, and in parts of the county the drainage system is immature.

Although there is a wide range in temperature the climate is healthful. The rainfall is generally ample for crop growth. Nearly one-half of the annual precipitation occurs during the months of April, May, and June.

The population of the county is 19,379, the greater part being of foreign descent. Wahpeton, the county seat and the largest town, has a population of about 3,000. It is a junction point of several railroads.

There are four different railway systems in the county, which afford excellent transportation facilities, and, besides these, the Fargo and Southwestern, a branch of the Northern Pacific, passes within 1 mile of the northwestern corner of the county. There are 75 elevators in the county, which handle grain for Minneapolis and Duluth markets.

About 71.6 per cent of the farms of the area are operated by the owners. The tenanted farms are leased on a share basis, usually for

one-half the crop. Wheat, oats, barley, and corn are the principal crops. Land ranges in value from $10 to $50 an acre, depending on location, type of soil, market facilities,etc.

The soils range from clay to sand and are derived from glacial material, either laid down as terminal and ground moraines, or as the same material reworked by streams and deposited in ancient Lake Agassiz, a part of these deposits being in the form of a delta at the ancient mouth of the Sheyenne River. Fifteen different soils, two of them phases of established types, are shown on the soil map.

The Fargo loam, 320 square miles or 22 per cent of the area of the county, is well adapted to general farming, producing good yields of wheat, oats, barley, and corn. The drainage is fair and crops seldom suffer from drought. This land is valued at from $30 to $40 an acre, and ranks among the best soils in the county.

The Fargo clay loam is the heaviest soil in the county cultivated to any extent. It generaly contains a high percentage of organic matter and in average seasons produces excellent yields of small grains. In wet seasons, however, there is an excess of moisture and the yields are sometimes small. It is not well adapted to durum wheat, and Bluestem is generally grown. Its value is about the same as that of the Fargo loam, or possibly slightly less.

The Fargo clay is the heaviest soil in the county and is generally uncultivated. It occurs near the Red River and is poorly drained. Its organic matter content is very high, and with perfect drainage it would produce fine crops. It is a difficult soil to cultivate.

The Fargo fine sandy loam, 341 square miles or 23 per cent of the area of the county, is the most extensive type mapped in the county. It is well adapted to general farming and especially to durum wheat and corn. It is valued at $20 to $35 an acre.

The Fargo sandy loam is very similar to the Fargo fine sandy loam, practically the only difference being in the subsoil. It produees slightly better yields than the latter type and its value is therefore slightly higher.

The Marshall loam occupies most of the unmodified drift area of the county, and the topography is from gently rolling to hilly. In seasons of excessive rainfall or of drought the soil is one of the best in the area, and an entire crop failure rarely occurs. It is valued at $30 to $40 an acre.

The Fargo silt loam covers a comparatively small area, but it is one of the best soils of the county, being well adapted to general farming. Its value is about the same as that of the Fargo loam.

The Wabash loam is the only alluvial soil in the county. It has a wide variation in texture, but all phases generally produce good yields.

The Fargo fine sand, Dunesand, and Meadow are types having the lowest agricultural value. They are practically all uncultivated, being generally used for hay or pasture land. The swamp phase of the first type is uncultivated at present because poorly drained. If reclaimed it would have a much higher crop value than the rest of the soil.

The Fargo gravelly loam covers small areas and is unimportant.

The county is generally in a prosperous condition and offers opportunities for various lines of farming and stock raising.